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Le tome 2 des Actes du Symposium international en activité physique adaptée reproduit les textes de quatorze communications scientifiques portant principalement sur le développement psychomoteur et sensori-moteur des enfants handicapés physiques ou déficients mentaux.

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ADAPTED PHYSICAL ACTIVITY
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Motor ability of EMR, TMR, and nonhandicapped children

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Introduction

Past research on mentally retarded children has shown that these children developmentally lag behind children of normal intelligence. Mentally retarded children, primarily educable mentally retarded, have been compared to nonhandicapped children on a limited variety of motor skill and fitness tasks (Stein, 1963). Such a variety of tasks and lack of normative data presents difficulty in comparison of the results from investigation to investigation, as well as from subject sample to subject sample within studies.

Normative data for mentally retarded children on physical fitness and motor performance items have been developed (Rarick, Widdop & Broadhead, 1970). The limitation of the nature of the tasks in normative data has not afforded a great deal of information about the motor characteristics of the mentally retarded child.

There is need for further comparative investigation of mentally retarded children, both educable mentally retarded (EMR) and trainable mentally retarded (TMR), and nonhandicapped children on a wide range of motor skill tests, for both the purpose of increasing the understanding of the motor characteristics of the retarded and for the purpose of being able to design better physical activity curricula programmes. This study, therefore, contrasted the performance of EMR, TMR, and nonhandicapped children on a comprehensive battery of fine and gross motor measures. Fine motor acts are performance requiring small muscle movements of the fingers, hand, and forearm and generally involve some element of eye-hand coordination, whereas gross motor acts involve the use of the larger muscles of the shoulders, trunk and legs (Espenchade, 1940). Measures used in this study included fine and gross motor composite tests, as well as measures of more specific areas of

motor performance.

Method

Subjects

The mentally retarded children consisted of mildly retarded (EMR) and moderately and severely retarded (TMR) children. Each handicapped child was matched for age (within three months) and sex with a non-handicapped child enrolled in a regular classroom. Mildly retarded children ($N = 72$) were in special education schools or classrooms and had IQ scores on individual tests between 50 and 75; severely retarded children ($N = 19$) were attending a special school for trainable pupils and had IQ scores between 30 and 50. EMR and TMR children obtained mean IQ's of 64 and 39, respectively. Table 1 presents summary characteristics for the comparative groups.

Contrast children for the study were drawn from 892 subjects included in the normative sample of the Bruininks - Ozeretsky Test of Motor Proficiency (Bruininks, in press). Subjects included in the normative sample had been selected at random from a large number of classrooms within 32 schools in Ontario, Canada, and in four different states in the United States. The sampling strategy used to norm the test ensured broad geographic distribution of subjects from school districts in the midwest, west, south, and east. The sample was chosen to approximate the U.S. school population in terms of distribution of boys and girls, community size, and race, as reported in the 1970 U.S. Census statistics. All contrast children were enrolled in regular classes, and none was reported by teachers to exhibit any serious learning or adjustment problems. Thus, selection procedures used in the study assured a random cross-section of school children for the contrast sample. Because of the sampling procedure followed, there is reason to believe that the contrast children were representative of the school population generally in academic achievement and motor development.

Table 1

Descriptive information on handicapped and contrast samples

Group/measure	Handicapped sample			Contrast sample		
	Range	Mean	SD	Range	Mean	SD
Mildly retarded (N = 70)						
CA	71-168	122.92	25.46	69-169	122.93	25.65
IQ	51-75	64.17	7.07	NA ^a		
Severely retarded (N = 18)						
CA	74-163	120.47	28.47	74-164	120.10	28.76
IQ	29-50	30.33	6.26	NA ^a		

^aNot available

Measures

The standardization version of the Bruininks - Ozeretsky Test of Motor Proficiency (Bruininks, in press) was administered to each subject individually by trained examiners. This test is designed to serve as a general survey and diagnostic scale of motor skills development for handicapped and nonhandicapped school children, assessing fine motor coordination, gross motor coordination, fine motor speed and precision, and balance.

Areas assessed by the scale are described by the following subjects:

Running speed and agility. Consists of a 30 yard shuttle run.

Balance. Assesses the pupil's ability to maintain bodily equilibrium in a stationary position or in the act of movement.

Bilateral coordination. Assesses the pupil's ability to coordinate hands, feet, or hands and feet in various sequential or simultaneous patterns using both sides of the body.

Strength. Includes sit-ups, push-ups, and standing broad jump.

Upper limb coordination. Assesses the pupil's abilities in visual tracking and gross motor coordination of eyes and hands.

Response speed. Measures speed of responses to a moving visual stimulus.

Visual-motor control. Assesses fine eye-hand coordination using paper and pencil tasks.

Upper limb speed and dexterity. Measures manipulative dexterity, hand speed, and arm speed.

The subtest structure of the scale is based upon literature on the motor development of children, a factor analysis of test items, and results from previously published factor structure studies. It is also possible to summarize test performance into gross motor and fine motor composite scores.

Reliability for the subtest and total test scores is presently based on a test-retest study of 80 school students over a two-week interval and interscorer agreement studies on selected test items. Test-retest correlations for subtests range from 0.50 to 0.92, with a coefficient for total and composite scores of 0.96. (These coefficients

are higher for younger than older children). Correlations among independent raters for test items requiring judgment are quite high, generally in the range of 0.80 to 0.95. Subtest correlations with chronological age within the normative sample are quite high (generally between 0.70 and 0.85), indicating the scale is a developmental measure of motor performance (Bruininks, in press).

Samples of mentally retarded students and nonhandicapped students were compared on their subtest scores as well as on total test and on fine motor and gross motor composite test scores. Gross motor and fine motor composite scores are derived using conversion tables that give equal weighting to each of the following subtests:

Gross Motor Composite

gross motor speed
balance
coordinated movements
strength

Fine Motor Composite

response speed
visual-motor control
upper limb speed and dexterity

Age scores were employed in a comparison of composite scores so that equal weighting could be given to each subtest, while raw scores were used in subtest comparisons.

The magnitude of differences between the two samples on each measure was determined by means of t tests for independent groups, using the .05 level as a criterion of statistical influence.

Results

The results of comparing the motor performance of EMR and nonhandicapped children, are presented in tables 2 and 3 respectively. The two samples of retarded children were significantly inferior to contrast subjects on all subtest, total scale, fine motor and gross motor scores.

Performance of the two retarded groups are displayed graphically in figures 1 and 2.

Age-matched TMR students were approximately 16 to 96 months below the normative scores of the nonhandicapped students. Compared to the nonhandicapped students they were most deficient on the Bilateral Coordination Movements Subtest, which was comprised of items testing the

Table 2

Comparison between handicapped and nonhandicapped students
on subtest and total test performance^a

Sample/score	Handicapped sample		Contrast sample		t
	$\bar{X}$	SD	$\bar{X}$	SD	
<u>Mildly retarded (N = 72)</u>					
I Running speed and agility	6.14	3.76	9.22	1.90	-6.21***
II Balance	5.85	3.58	9.38	3.25	-6.19***
III Bilateral coordination	11.54	5.31	18.62	3.82	-9.19***
IV Strength	11.86	5.49	17.32	3.10	-7.35***
V Upper limb coordination	27.17	9.85	40.83	10.05	-8.24***
VI Response speed	12.04	5.51	20.43	6.39	-8.57***
VII Visual-motor control	5.83	3.33	11.06	3.56	-9.09***
VIII Upper limb speed/dexterity	16.01	6.97	23.83	4.56	-7.96***
<u>Composite scores</u>					
Total test	81.10	22.79	121.15	24.59	-10.14***
Gross motor battery	80.92	21.41	122.39	24.77	-10.75***
Fine motor battery	84.92	23.57	124.25	25.25	-9.66***
Short form	79.81	21.57	122.31	26.34	-10.59***

^aSubtests are in raw score units; total scores are in age scale units.

*** $p < .001$.

Table 3
Comparison between handicapped and nonhandicapped students
on subtest and total test performance^a

Sample/score	Handicapped sample		Contrast sample		t
	$\bar{X}$	SD	$\bar{X}$	SD	
<u>Moderately/severely retarded (N = 19)</u>					
I Running speed and agility	3.05	2.84	9.68	2.05	-8.25***
II Balance	2.42	3.22	8.95	3.24	-6.23***
III Bilateral coordination	4.42	2.98	18.11	3.37	-13.26***
IV Strength	6.53	4.59	17.05	3.85	-7.66***
V Upper limb coordination	15.26	6.45	40.79	11.09	-8.68***
VI Response speed	7.58	4.33	21.53	7.12	-7.30***
VII Visual-motor control	2.16	1.63	12.26	3.16	-12.39***
VIII Upper limb speed/dexterity	6.84	4.88	24.63	3.74	-12.61***
<u>Composite scores</u>					
Total test	57.95	9.96	129.58	26.67	-10.97***
Gross motor battery	57.63	10.58	123.16	28.11	-9.51***
Fine motor battery	58.89	10.32	120.68	27.38	-9.20***
Short form	58.21	6.83	126.26	30.53	-9.48***

^aSubtests are in raw score units; total scores are in age scale units.

*** $p < .001$.

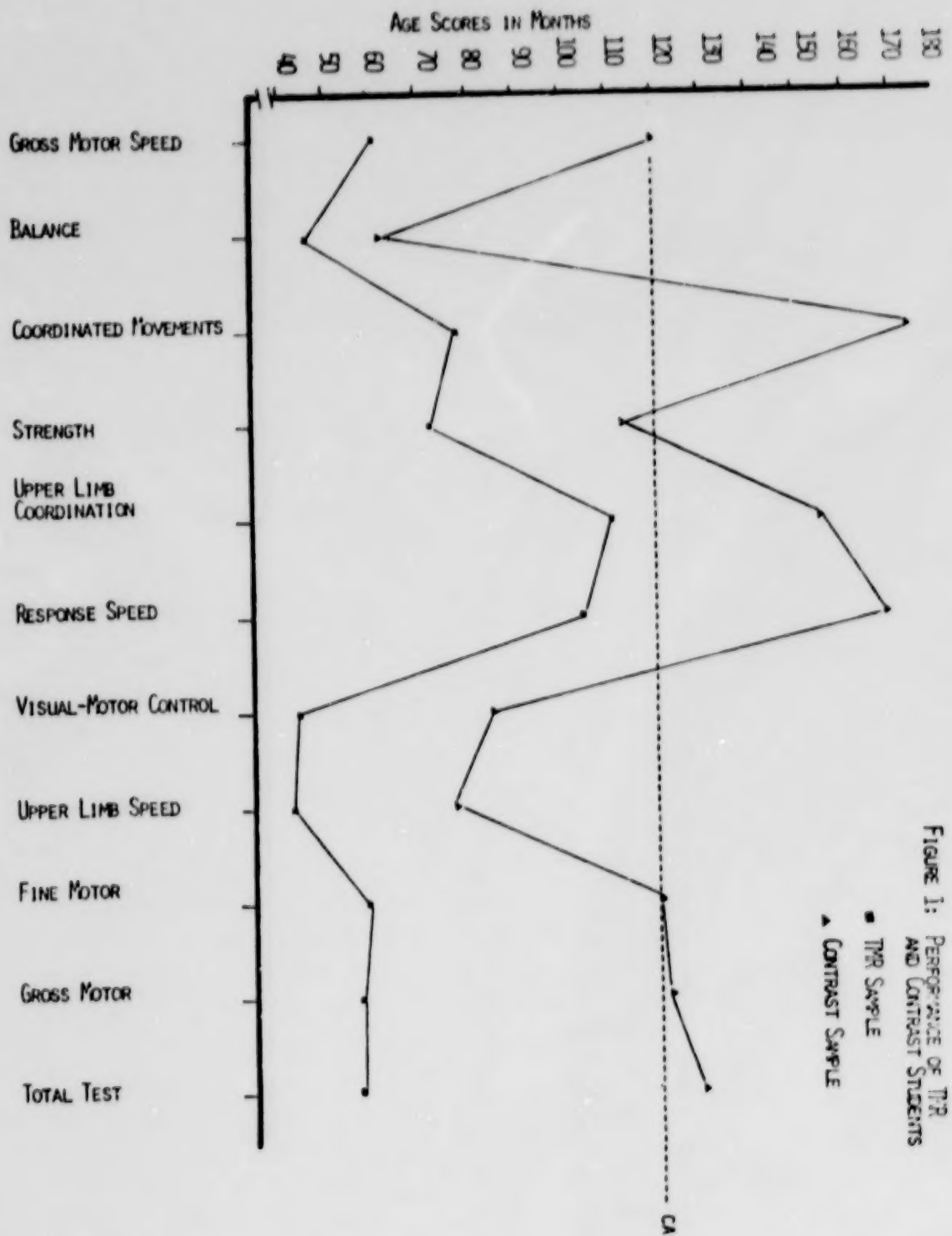


FIGURE 1: PERFORMANCE OF TTR AND CONTRAST STUDENTS

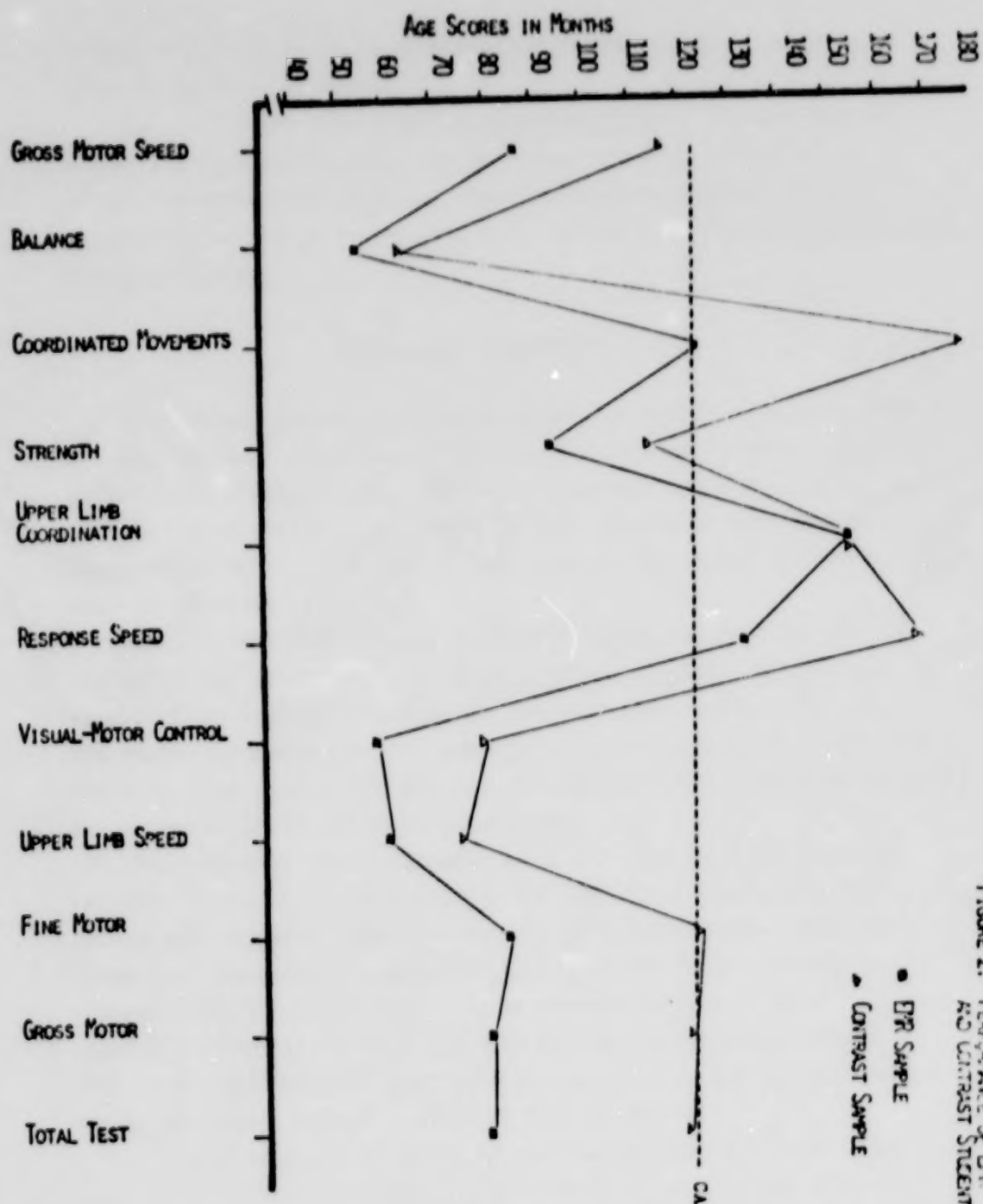


FIGURE 2: PERFORMANCE OF EPI AND CONTRAST STUDENTS

student's ability to coordinate movements with his hands and/or feet in specific patterns of motion.

Except for the Upper Limb Coordination Subtest, age-matched EMR students were approximately 9 to 54 months below the normative scores of the nonhandicapped students. The EMR students compared to the nonhandicapped students were most deficient on the Bilateral Coordination Movements Subtest.

Summary and discussion

Performance comparisons were made between mentally retarded, EMR and TMR, and nonhandicapped children on a standardized battery of gross motor and fine motor tasks. Differences between mentally retarded and nonhandicapped children were found in both fine motor and gross motor composite measures, with the TMR group having the largest difference in motor performance.

The similarity of the age equivalent scores for both the EMR and nonhandicapped students on the Upper Limb Coordination Subtest is a result of the characteristic of the age equivalent score. The maximum age equivalent score for this subtest is 13 years (equal to a raw of 21) for which both groups, EMR and nonhandicapped students had exceeded with raw scores of 27.17 and 40.83 respectively.

The composite scores for both gross and fine motor performance reflects a great difference between the mentally retarded and nonhandicapped students. The EMR students were approximately 40 months lower than the nonhandicapped students while the TMR children were approximately 60 months lower than the nonhandicapped students. These results are similar to those found by Rarick and colleagues (1970, 1976) who found mentally retarded boys and girls to lag approximately two to four years behind in motor skill development.

It is of interest to note that even though fine and gross motor tasks do differentiate groups of mentally retarded children from nonhandicapped, individual subjects from the mentally retarded group did score as well as individuals from the nonhandicapped group. The age equivalent scores for the EMR and nonhandicapped students were different

by only nine months on the Balance Subtest. Rarick (1976) has also found that EMR children score as well as or better than nonhandicapped children on such items as elbow flexion and extension, and the PWC₁₇₀. Perhaps factors other than cognition alone are responsible for the difference in motor skill development between mentally retarded and nonhandicapped children with normal intelligence.

Should it be possible that mentally retarded children are capable of achieving levels of skill development comparable to nonhandicapped children, then it is of prime importance that curriculum and physical activity experiences are developed to encourage this process of learning.

To develop curricula that will satisfy the needs of mentally retarded children, a knowledge of the motor characteristics of the retarded child is necessary. The evidence presented in this paper indicates that scores of the Bruininks - Ozeretsky Test of Motor Proficiency differentiate performance levels and development between handicapped and nonhandicapped children. The test then appears useful as a developmental measure of motor performance from which appropriate activities can be prescribed to assist the child develop gross and fine motor skills in those areas in which he is less skilled.

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Vitesse d'apprentissage et rétention à long terme
d'une tâche motrice chez des garçons normaux
et des garçons déficients mentaux*

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Introduction

L'étude analyse la rétention à long terme des habiletés perceptivo-motrices chez des garçons normaux et des garçons déficients mentaux. Les précédentes recherches (Caron, Swalus & Vachon, 1976; Caron, Lamirande-Blouin & Vachon, 1976) tout comme les revues de la littérature qui les avaient précédées (Caron, Lyons & Vachon, 1975; Caron, 1976), laissent voir qu'en certaines circonstances, les effets du surapprentissage sur la rétention perceptivo-motrice à long terme semblent être les mêmes chez les déficients mentaux éduqués que chez les normaux. Cependant, l'on connaît encore trop peu les effets sur la rétention à long terme de la vitesse d'apprentissage. La question est de savoir si on observe plus d'oubli après un apprentissage rapide ou après un apprentissage lent.

Les buts de la recherche sont de vérifier: (a) si, lors de la phase d'apprentissage ou celle de surapprentissage, différentes vitesses d'apprentissage agissent de la même façon sur la rétention à long terme; (b) s'il existe des différences entre les normaux et les déficients mentaux lorsqu'il s'agit d'une tâche prioritairement motrice de nature continue dont le contrôle semble dépendre principalement du feedback kinesthésique. De plus pour compléter l'étude, la vitesse de réapprentissage après un intervalle de rétention à long terme fut étudiée chez

*Etude subventionnée, en 1976-77, par le programme DGES-FCAC, Ministère de l'Education, Gouvernement du Québec.

les individus dont la célérité à apprendre était rapide, moyenne ou lente.

Méthodologie

Sélection des sujets

Les 69 garçons sélectionnés pour étude furent répartis en trois groupes: 27 Déficients Mentaux éduqués, DM, ($\bar{M}$ âge = 136.2 mois, $s = 13.2$; $\bar{M}$ QI = 71.3, $s = 3.7$; $\bar{M}$ âge mental = 73.7, $s = 10.9$); 31 Normaux appariés en Age Chronologique, NAC, ($\bar{M}$ âge = 125.5 mois, $s = 16.4$); 11 Normaux appariés en Age Mental, NAM, ($\bar{M}$ âge = 78.0 mois, $s = 8.6$). Aucun des sujets ne devait présenter de trouble apparent, soit physique, moteur, affectif ou sensoriel.

Pour chaque groupe, le choix des sujets et les traitements furent assignés, au hasard, à deux sous-groupes: l'un d'apprentissage et l'autre de surapprentissage. A partir du nombre d'essais requis pour atteindre le critère respectif des sous-groupes, tous les sujets étaient classés en sections différentes de vitesse d'apprentissage, rapide, moyenne, lente. Dorénavant, les six sous-groupes seront identifiés comme suit: DMA, NACa, NAMA (apprentissage); DMs, NACs, NAMS (surapprentissage).

Plan expérimental

Au premier jour du traitement, les six sous-groupes (DMA, NACa, NAMA; DMs, NACs, NAMS) devaient réaliser la tâche définie jusqu'à l'atteinte d'un critère d'apprentissage pré-établi de 18 secondes sur 30 en équilibre. Au deuxième jour du traitement, les sous-groupes DMs, NACs, NAMS, poursuivaient l'apprentissage de la tâche jusqu'au critère de 22 secondes sur 30 en équilibre. Quarante-huit heures ou un mois après que les sous-groupes expérimentaux aient atteint les critères d'apprentissage déterminés, les sujets des sous-groupes devaient atteindre de nouveau leur critère respectif d'apprentissage initial.

Appareil: choix, description et fonctionnement

L'appareil employé fut le stabilomètre et la tâche d'équilibre dynamique demandée devait être effectuée, vue obstruée; le temps total en déséquilibre enregistré, à chaque essai, était au .01 de seconde

près. Un nombre élevé de secondes ou d'essais correspond à une faible performance et vice-versa. Dès que le sujet était en déséquilibre pendant l'exécution de la tâche, un signal sonore se faisait entendre. Le cycle de chaque essai était 30 secondes de travail, 50 secondes de repos.

Traitement statistique

Le temps en déséquilibre ainsi que le nombre d'essais requis lors de l'apprentissage, du surapprentissage et du réapprentissage constituent les données de l'étude.

La vitesse correspond au total des essais requis: (a) pour la vitesse d'apprentissage, du premier essai jusqu'à l'essai-critère (12 secondes sur 30 en déséquilibre); (b) pour la vitesse de surapprentissage, du premier essai-critère jusqu'au deuxième essai-critère (8 secondes sur 30 en déséquilibre); (c) pour la vitesse de réapprentissage, du premier essai de rétention jusqu'à l'atteinte du critère initial et spécifique antérieurement atteint.

La variable modératrice correspondait à la taille du sujet et les analyses de la covariance furent réalisées: (a) pour le critère d'apprentissage temps total et la rétention à long terme: en secondes de déséquilibre; (b) pour la vitesse d'apprentissage: en nombre d'essais requis pour atteindre le critère fixé. Puisque les statistiques t de Bonferroni servirent à l'exécution simultanée des inférences statistiques, l'alpha global devait donc être considéré dans l'étude comme étant inférieur ou égal à .10.

Résultats et discussions

Les principaux résultats des groupes qui apparaissent aux tableaux 1 et 2 et qui sont illustrés dans les figures 1 et 2 se résument ainsi:

Chez les DM et les NAC à la phase de surapprentissage, (a) la vitesse de surapprentissage est la même pour les individus rapides et moyens, mais elle est significativement différente lorsque les sujets lents sont comparés aux rapides, aux moyens; (b) aucune différence significative n'existe en vitesse de réapprentissage, en rétention à long terme, pour les individus rapides, moyens ou lents à apprendre.

Tableau 1

Résultats des sous-groupes

Sous-groupes ^a	Niveau initial (sec. déséq.)		Vitesse ap- prentissage ^b (n. essais)		Vitesse réap- prentissage (n. essais)		Rétention long terme (sec. déséq.)	
	<u>M</u>	<u>s</u>	<u>M</u>	<u>s</u>	<u>M</u>	<u>s</u>	<u>M</u>	<u>s</u>
Apprentissage								
DM rapide	15.90	2.3	5.6	2.9	3.2	1.2	12.32	1.7
DM moyen	19.33	2.1	27.7	6.5	5.1	2.8	14.87	1.9
NAC rapide	15.15	2.6	5.4	3.6	3.7	2.3	12.91	2.1
NAC moyen	15.75	2.4	18.5	5.0	7.5	4.5	13.54	2.4
NAM rapide	15.51	2.9	3.9	2.0	3.3	2.9	11.85	3.2
NAM moyen	19.40	2.2	17.5	6.7	3.0	1.6	11.73	2.6
Surapprentissage								
DM rapide	19.40	2.8	6.3	2.8	5.1	2.8	11.52	2.3
DM moyen	18.50	1.4	19.0	2.2	7.0	2.2	12.21	1.0
DM lent	19.65	1.9	55.0	19.7	7.3	1.1	12.67	1.8
NAC rapide	11.72	2.2	4.0	2.8	4.7	3.1	10.60	1.7
NAC moyen	16.52	2.2	18.3	5.4	6.2	2.3	12.17	2.4
NAC lent	17.07	2.7	59.3	23.6	9.7	6.1	11.32	1.3

^aDM (Déficients Mentaux); NAC (Normaux appariés aux DM en Age Chronologique); NAM (Normaux appariés aux DM en Age Mental).

^bSeuls les sous-groupes de surapprentissage étaient de niveaux équivalents au départ de la prise de mesure de la vitesse.

Tableau 2

Analyses univariées de la covariance

Hypothèses ^a ($d_1 = 1,56$)	Niveau initial	Vitesse ap- prentissage	Vitesse réap- prentissage	Rétention long terme
	<u>F</u>	<u>F</u>	<u>F</u>	<u>F</u>
Apprentissage				
$U_1 - U_2$	1.48	19.18***	.35	1.22
$U_4 - U_5$	.02	4.37*	1.99	.00
$U_7 - U_8$	5.82	8.34**	.03	.01
Surapprentissage				
$U_1 - U_2$	.35	2.58	.57	.20
$U_1 - U_3$	.51	35.92***	.78	.54
$U_2 - U_3$	1.21	12.42**	.00	.04
$U_4 - U_5$	10.43***	3.51	.48	1.37
$U_4 - U_6$	4.69*	35.75***	3.75	.13
$U_5 - U_6$	.28	21.38***	2.03	.41

^a U_1 (DM rapides); U_2 (DM moyens); U_3 (DM lents); U_4 (NAC rapides);
 U_5 (NAC moyens); U_6 (NAC lents); U_7 (NAM rapides); U_8 (NAM moyens).

* $p < .05$.

** $p < .01$.

*** $p < .001$.

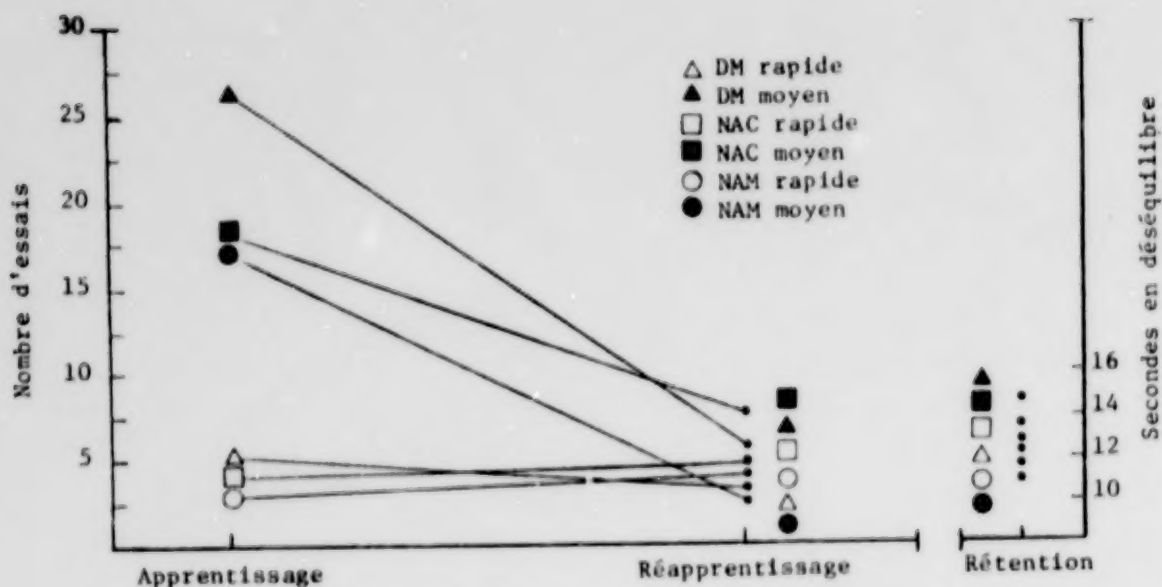


Figure 1. Sous-groupe apprentissage chez les sujets à vitesse d'apprendre rapide et moyenne des trois groupes: comparaison en vitesse d'apprentissage, en vitesse de réapprentissage et en rétention à long terme.

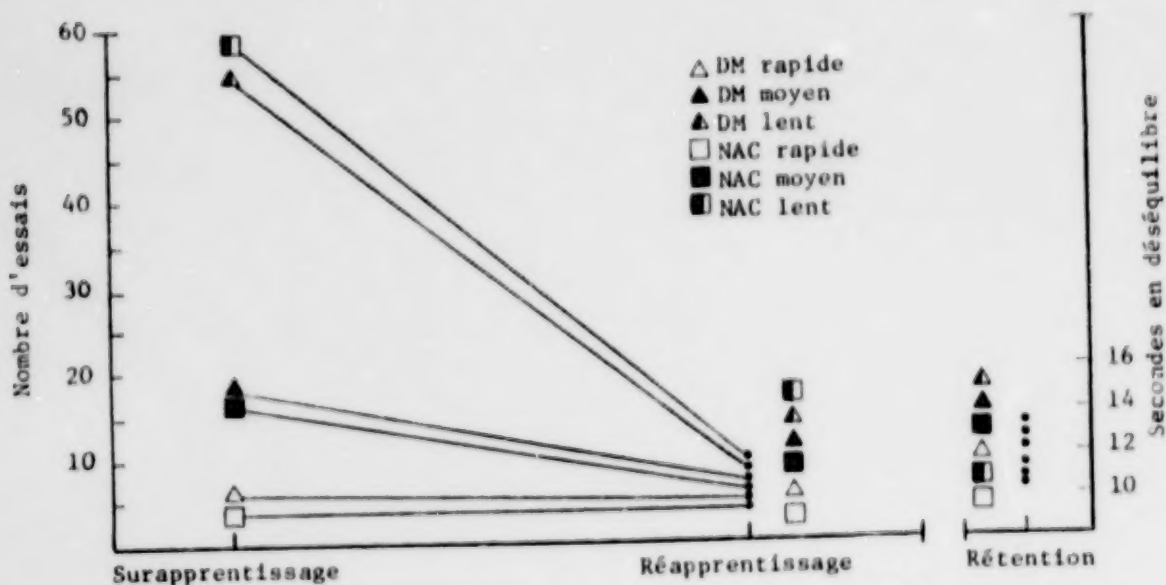


Figure 2. Sous-groupe surapprentissage chez les sujets à vitesse d'apprendre rapide, moyenne et lente des groupes DM et NAC: comparaison en vitesse de surapprentissage, en vitesse de réapprentissage et en rétention à long terme.

Chez les DM et les NAM à la phase d'apprentissage, la vitesse d'apprentissage - mesurée de façon traditionnelle - indique que les individus rapides, lorsque comparés à ceux de vitesse moyenne, obtiennent des résultats supérieurs jugés significatifs. Chez les DM, NAC et NAM, aucune différence significative n'existe en vitesse de réapprentissage, en rétention à long terme, pour les individus rapides et moyens en célérité à apprendre. Aucune différence significative n'a été observée dans la comparaison des sous-groupes au niveau initial de performance. Les résultats observés appuient ceux trouvés antérieurement, entre autres, par Smith (1975).

Conclusion

La vitesse de réapprentissage ne semble pas être influencée par la vitesse d'apprentissage ou de surapprentissage: une célérité lente ou rapide lors de l'apprentissage ou du surapprentissage n'entraîne pas nécessairement un réapprentissage lent ou rapide. Chez les DM, NAC, et NAM, les résultats obtenus indiquent que la rétention d'une tâche prioritairement motrice n'est pas affectée par les vitesses d'apprentissage ou de surapprentissage. Ainsi, l'affirmation populaire qu'un apprentissage rapide entraîne un plus grand oubli, et vice versa, n'est pas confirmé par cette étude. La vitesse d'apprentissage, de surapprentissage, de réapprentissage ainsi que la rétention à long terme d'une tâche prioritairement motrice ne sont donc pas nécessairement associées à l'âge mental.

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The effects of a movement program on the development
of motor patterns and skills of young handicapped children¹

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The importance of movement in the development of normal children has been rather well established and the effects of deprivation of freedom of movement well studied in the past. In children with chronic neurological handicaps of various types there is an imposed limitation on the use of the environment and a possible detrimental effect to the development of maximum potential. Many programs of therapy and physical education have been developed to meet the needs of these children, yet the literature is somewhat lacking in good research regarding the efficacy of many of these procedures. In the past the impetus for programming occurred when the child entered school, yet it is known that this is too late for many children, particularly the handicapped. In most institutions where young handicapped children are being taught there has been virtually no attempt made to assess the movement patterns of these young children or to plan viable movement programs.

Purpose

The study was designed to research the efficacy of a concentrated movement program in order to determine the effects of teaching on motor pattern and skill development of young handicapped children.

¹This study was conducted at the Society for Crippled Children, Winnipeg, Manitoba, Canada. The study was funded over a three year period by the Manitoba Medical Services Foundation, Inc. The writer was formerly a professor at the University of Manitoba.

The study also proposed to develop a reliable testing instrument which could be used to analyse the movement patterns of normal and handicapped children between the ages of 2 and 5 years and to develop and implement a program model which would guide future decisions at the Society for Crippled Children, Winnipeg and elsewhere in the selection of appropriate equipment, program activities and teaching strategies.

Definition of terms

Movement education

As used in this study, refers to that aspect of either physical education or classroom education which deals with development and training in basic movement patterns.

Movement pattern

Refers to a series of movements organized in a particular time-space sequence ranging from almost random movement to highly structured and complex movement.

Motor skill

Is a motor activity performed with a high degree of accuracy.

Review of literature

Throughout recorded history educators of the young have shown evidence of understanding the worth of movement in school programs. The writings of Plato (1924), Rousseau (1911), Montessori (1912) and more recently Kephart (1960), Barsch (1967) and Cratty (1971) have attested to the validity of movement experiences in the life of the child.

In the case of handicapped children Cratty (1971) indicates that physical education programs, if properly utilized, can make important contributions to children with learning disabilities and hyperactive children. Cooper (?) indicates that planned interventions are necessary for adequate motor skill to develop. Corbin (1973) states

that environments restricted in sensory stimulation have resulted in retardation of social, motor and intellectual development. Studies by Oliver (1958), Corder (1965), Hayden (1966), Carter (1966) and the writings of Stein (?) all indicate that when retarded children are systematically taught their achievement can approximate the level of the normal population.

Movement programs have been suggested as powerful tools in rehabilitation and socialization programs of children with cerebral palsy. Sensory motor training, according to Adams (1975), can improve perceptual and constructional difficulties associated with cerebral palsy. Fait (1972) indicates that physical education and physical therapy should complement each other in the education of cerebral palsied children and should not be considered duplicates of or substitutes for the other.

Buell (1975) states that blind children, when given the opportunity, can perform as well as normal children in many of the subtests of fitness and urges parents to seek participation in physical activity for their young blind children.

Stein (1975) recently suggested that asthmatic children should be allowed to participate in physical activity and that exclusion from activity should be as infrequent as possible. Recent research by the Epilepsy Foundation (1974) points to a lessening of the constraints on participation of children with convulsive disorders in physical activity and competitive sports. Vigorous activity appears to reduce seizure potential of persons with epilepsy rather than causing additional seizures.

The American Diabetes Association (1966) advocates exercise as one of the most necessary ingredients in the treatment of diabetes. Sherrill (1976) states that, with the exception of his physician, perhaps no one is more important to the diabetic child than his physical education teacher.

Whitehurst (1971) indicates that movement education for some children may be one of many avenues to the goal of self-actualization. For others it may be a pump-primer to get the flow of interest flowing. And for still others it may be the only way.

Procedures

Subjects selected for this study were 78 children participating in existing pre-school programs at the Society for Crippled Children, Winnipeg, Manitoba, Canada. The children were between the ages of 2½ - 5 years and were designated as being mentally handicapped, language disordered, hearing impaired or physically handicapped.

Screening of subjects was determined by use of the Motor Patterns Achievement Profile designed by the investigators. The instrument was designed after review of the literature and correspondence with numerous researchers and teachers led to the conclusion that no instrument was available which could effectively measure the motor patterns of skills of such young subjects or subjects who, in many cases, were multiply handicapped.

Subjects were assigned to experimental and control groups using the stratified random sampling technique. Experimental subjects received instruction in selected developmental motor tasks for 4-20 minute periods per week. Subjects in the control groups received no instruction but were exposed to the same equipment and instructors as the experimental groups.

The investigation was conducted as a blind study in that classroom teachers, therapists, parents and supervisors were not aware of which subjects were in the experimental group or which were in the control group.

The Movement Patterns Achievement Profile was administered to all subjects at the completion of 44 or 22 lessons. Because of the apprehensiveness of subjects in the testing situation the test was administered by one of the researchers and scored by the other researcher and a trained outside observer.

Analysis of the data

Reliability of the Movement Patterns Achievement Profile

Test-retest reliability based on a six week test-retesting was computed using the Spearman Rank-Order Correlation technique. Five of

the 14 items (walking, running, downward jumping, ascending and descending stairs) showed an overall reliability coefficient of .8. The remainder of the items (jumping forward, ladder climbing and descending, throwing, static and dynamic balance) had coefficients of .6 or above.

Critical analysis of the testing instrument

In order to determine the common factor(s) which was (were) being tested a factor analysis was computed for all groups on each sub-test. A "principal factor" solution was computed using the BMD P4M program included in the Biomed Statistical Package. Squared multiple correlations between each item and the rest of the items in the test were used as communality estimates, which were interacted until the difference between two successive communality estimates did not differ by a criterion of .01.

The program was then instructed to retain any factor which could account for at least an amount of the total variance of a single variable, i.e., any factor with an eigen value greater than or equal to 1. Only one factor was retained; it accounted for 64% of the total test variance and all the test items had loadings on this factor equal to or greater than .60. With the exception of two items (catching and body image) the correlations of each sub-test were extremely high indicating construct validity.

Inter observer reliability

The Spearman Rank Order Correlation Coefficient was computed to determine inter-observer reliability. For the first year of the study a coefficient of .87 was computed; for the second year of the study a coefficient of .82 was computed.

In order to determine the effects of instruction on movement pattern and skill development of young handicapped children a 2 x 2 Repeated Measures Analysis of Variance Group Testing Occasion was computed. The 5% level of significance was used. The data was analyzed in terms of total scores (minus catching and body image) from pre-test 1, September 1974 to post-test 3, June 1976 for all two year were analyzed over the period September 1976 - June 1976.

Significant improvement in favor of 3 out of 4 of the experimental groups was shown. Groups showing significant difference were the mentally retarded (1 and 2 years), the orthopedically handicapped (1 year) and the deaf group. No significant difference was found in the case of the language disordered group undoubtedly due to the disparity of the sample.

Based on the statistical evaluation and within the limitations of the study it may be stated that subjects in the mentally retarded and orthopedically handicapped experimental groups made more significant gains in terms of movement pattern and skill development than the control groups. With controlled matching it is suggested that the language disordered group might have also shown this trend.

Discussion

Outside of the statistical evaluation indicating change in favor of the experimental groups, it is suggested that there was an accompanying social change in many subjects as a result of the program. Some subjects learned how to play, some became more aggressive, some less aggressive and some more courageous. Many subjects learned how to interact socially.

The researchers were aware of the criticism of the investigator bias when an instrument is designed, subjects are tested and program is administered by these same investigators. Since behavioral research with young handicapped children, if it is to be conducted at all, must often employ these techniques the integrity of the research team is of the utmost importance and should be considered by the readers of this abstract.

Halverson (1971) indicates the problem of evaluation of motor skills of young children:

The problem of a strange environment with a strange adult needs little expansion. It is obvious that for many or most children, the performance recorded at such a session is likely to be less than their potential or, at least different from it. The adult who does not know children, particularly with whom he is working, will end up with some strange data (12:23).

Conclusions

1. Intervention in programming is necessary when dealing with handicapped children. The structuring of the environment alone will not bring about a change in behavior in most handicapped children.

2. Programs for some handicapped children, the mentally retarded, the language disordered, the deaf should be developmental rather than therapeutic. Because of heavy scheduling demands therapists often cannot work with mentally handicapped children with "lesser" motoric problems, yet there are some marked developmental and perceptual motor problems evidenced by these children.

3. Institutions where young handicapped children are being taught should not overlook the help available in the community in the teaching of these children. High School and University students; therapy, psychology, physical education and nursing majors can become part of the teaching team.

However, the primary responsibility for the development of movement skills should be that of the physical educator.

"Movement is too important to leave to chance".

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EMG biofeedback in physical therapy

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Clinical application of biofeedback techniques in neuromuscular conditions

The use of biofeedback is becoming increasingly valuable in the field of physical therapy. It has been proven effective in muscular re-education and muscular relaxation. Audio-visual muscular re-education techniques make use of electromyographic devices and amplify internal physiological processes in the body which is normally not seen or perceived by the therapist or the patient. Making use of auditory and visual feedback, the patient is given two other information inputs other than normally available to him with which to process information concerning physiological events.

Audio-visual neuromuscular techniques are an adjunct to all the other therapies commonly used. To use this technique, one should be well versed in many other applied sciences like electromyography, pathology, neurology, kinesiology and muscle re-education techniques. In this tape, we shall discuss the clinical application of audio-visual neuromuscular techniques which were discussed in tape one. Techniques discussed in tape one were inhibition of spasticity, recruitment of motor unit activity, muscle re-education of tendon transfers, muscle relaxation, and as an evaluation tool with incomplete spinal cord lesions. These techniques can be used alone, or sometimes in combination. In this tape, I shall illustrate how these techniques are used in different patients with different conditions and I shall give you some case illustrations. The types of patients we are familiar with are as follows:

1. Upper motor neuron lesions; (a) cerebrovascular accidents; (b) incomplete lesions of spinal cord injuries.

2. Lower motor neuron lesions; (a) peripheral nerve injury; (b) Bell's palsy.

3. Hysterical paralysis.

4. Muscle spasms of unknown etiology causing pain.

5. Spasmodic torticollis.

Cerebrovascular accidents

The residual paralysis of CVA's are normally treated by physical therapists whether it is spasticity, flaccidity or other problems associated with this syndrome. Normally, in the early stages, the physical therapy management is instituted to prevent deformity, to bring about movement and to improve functional activities and activities of daily living. However, in many patients, we are all aware that either flaccidity continues to exist for more than a few days due to spinal shock or as spasticity is exhibited, the patient is in synergy and unable to do normal functional activities due to lack of isolated movement. In many others, ambulation becomes a serious problem due to the presence of clonus. These three problems, spasticity, flaccidity, and clonus seem to be tenable to treatment by audio-visual neuromuscular re-education, in conjunction with standard therapeutic modalities.

Flaccidity

Patients who are flaccid after a CVA for more than a week or two weeks, should be started on this technique of treatment. The technique used for this problem is recruitment of motor unit activity as mentioned in tape one. The patient is first prepared physically and psychologically as presented in the first tape. Then the equipment is prepared and applied to the patient, taking all precautions as mentioned previously. The treatment commences. Having explained to the patient what is expected of him and having applied the electrode on the muscle or muscle groups that is to be treated, the patient is instructed to make as much noise as possible on the audio and to bring about activity on the scope which he can see and the therapist can see. Obviously, before treatment commences, the patient should be evaluated as to the amplitude of the activity seen on those muscles at rest and on passive movements and on active motions. Not only should the amplitude be noted, but also the interference pattern whether its complete, incomplete

or non-existent. As I pointed out earlier, the patient is asked to make as much noise as possible and to make sure that there is some activity seen on the scope. If nothing is seen, then the therapists start moving the joint or joints in question passively and tells the patient to attempt to do what the therapist is doing. If there is no success with this, then the patient is asked to do the action that is required with the good limb and at the same time trying to do the same motion with the affected one. This is cross facilitation. If this is not effective, gross motions are begun with the effective limb while at the same time the patient is working with the unaffected limb.

All of these strategies are used until something is seen on the scope and the audio. Tapping, stretching and vibration could be also added to the adjuncts that is used. Tapping on the muscle, stretching the effective muscle or vibrating the effective muscle with the electrodes in place are the three strategies used, so that the patient can bring about one little activity in that group of muscles which can be picked up by the audio and the oscilloscope. The moment you hear the first signs or the patient hears it and the therapist sees or hears it, then the patient is asked to continue to do whatever he did to bring about that noise. Sometimes, this strategy could be continued for a couple of days with no success and other times, it can be seen immediately rewarded within a few minutes of instituting this technique. If the technique is started sometimes in the lying position and results are negative, then it is worthwhile trying the treatment in other positions. If the technique becomes effective in the lying position, then the position is changed to the sitting position, and later to the standing position.

Now, I shall give you a case illustration of a patient. Mr. B. came to Mount Sinai with a monoparesis of the right lower extremity. The normal physical therapeutic procedures were tried on him for 2½ weeks with no success. A program of audio-visual neuromuscular re-education was instituted. What we were trying to do and what was expected of him was explained to the patient. His problem was a drop foot with no dorsiflexion and eversion. The patient lying down, surface

electrodes were placed on the tibialis anterior with a ground electrode placed next to it. The machine was on. The patient was instructed to do anything he could to make a noise on the audio. For a few minutes, this was tried, and as he could not make any response on the machine, the therapist stretched the dorsiflexors. This brought a few rumbles of activity which was heard on the audio and seen on the scope. The patient now built upon this, and within minutes, he was firing a few motor units although, he could not dorsiflex or evert the foot. The initial amplitude of motor unit activity was about 10 microvolts and interference pattern was incomplete. The patient continued to recruit motor unit activity. The therapist instructed the patient to dorsiflex the good foot. Then it was noted that there was an increment in motor activity and more noise was heard. The patient continued to come to physical therapy daily. A temporary short leg brace was given to the patient and the audio-visual neuromuscular techniques were continued. His motor unit activity continued to improve, his amplitude and interference pattern became near normal. At the end of three weeks, he had complete dorsiflexion and he was discharged from the hospital with a normal gait. It should be mentioned here, when the tibialis anterior began to show trace of motion and later range of motion, we still continued him on the audio-visual techniques in addition to the normal therapeutic techniques of muscle re-education. It could be said that because of audio-visual neuromuscular re-education, we were able to re-educate the paralyzed muscles in a shorter time. In short, I would go so far as to say that all patients who show flaccidity for more than a few days - 7 to 10 days - should be begun on audio-visual neuromuscular re-education, in addition to other techniques. The moment something is seen and heard which could not be perceived by the patient or the therapist, that activity is picked up and then the patient can continue to build on that minute amount of activity. It is the difference between flying with radar and flying without radar. In one instance, the pilot is flying blindly, but with radar he is flying with equipment which tells him his height, his position and his location. It is the same thing here. The therapist who treats his patient without seeing or hearing is like flying without instruments, and so is

the patient. But the moment the two additional inputs are given, the patient and therapist can see and hear which is a great help to the re-education process. It helps both the therapist and the patient physiologically and psychologically as they feel that something is returning, that would not have been seen or heard if not for this type of instrumentation. The ideal treatment protocol for this type of patient would be one-half hour of therapy everyday using audio-visual neuromuscular technique and the patient given a mini trainer or a portable EMG biofeedback unit to practice this strategy on his floor or at home two or three times a day for one-half hour each time.

Spasticity

Patients who are in synergy and whose muscles are in spasticity with no isolated motions present this technique could be instituted to break the synergy and bring about isolated motions, and thereby help activities of daily living. To bring about inhibition of spasticity and help return of isolated motions, one has to first inhibit spasticity of his agonists and then recruit motor unit activity of the antagonists. Finally, general relaxation techniques are used to bring about general relaxation of the whole body. So it is a question of judiciously using several techniques to bring about the desired motions. Let us take an example where the patient is in flexor synergy where the biceps of the patient is in spasm, the upper limb is in adduction at the shoulder, flexion of the elbow and flexion of the wrist. First as before the patient is evaluated to see the amount of spacticity of the biceps, at rest, on passive motion and on voluntary motion. This is noted. The interference pattern is also noted, whether it is complete, partial or incomplete. As before, the patient is prepared and the treatment begins. When the electrodes are placed on the biceps, one would see and hear activity even at rest. Now the patient is instructed to lower this sound level and to bring about silence. If the patient is unable to do this, then the therapist will instruct him to increase that activity by trying to do a motion in synergy. The moment he does that he could hear the rumblings on the audio and see the activity on the scope. Now, the therapist will instruct the patient to lower that. This is done a few times until the patient understands what is expected of him.

Sometimes the therapist might even stretch the elbow and the biceps and now the patient will try to relax it and thereby lower the noise. This is repeated a few times. The electrodes are now placed on the antagonists or the triceps group. The patient is now asked to bring about more sound by extending the elbow. These two procedures are done, first, inhibition of the biceps, and then motor unit recruitment of the triceps. Again, it should be pointed out that this type of therapy is not commenced on day one or day two. If no results are seen with the standard techniques available, only then do we recommend the use of these techniques. As you are aware, some of the patients may have a functional return without this treatment modality.

It is interesting that there are many documented reports of this technique used in the literature. Sometimes this technique could be used differently. Electrodes are placed on the biceps and the patient is now asked to extend the elbow and at the same time is told to lower the noise and the activity seen on the scope. This should be done gradually. Meaning a few degrees of motion at a time, whilst lowering the noise. Once he learns to extend the elbow a few degrees each time, lowering the noise, then he can move to the next stage. Sometimes because of spasticity in the biceps, the patient is unable to extend at all. Then the electrodes are placed on the triceps and the patient is asked to bring about motor unit activity. When he hears and sees the activity of the triceps, he is able to overcome this spasticity, or in spite of the spasticity he'll be able to get more range in extension. In this type of patient, recruitment of motor unit activity is done first and then inhibition of spasticity is done as a second technique. As I said before this strategy is to be used depending on the patient, and his problem and the expertise of the therapist himself. Like all other techniques of therapy, one has to grasp the problem and tailor the therapeutic strategies depending on the patient's needs. Here, I have to again mention a scientific truism, that is even normal people are unable to bring about inhibition of motor unit activity and learn to fire a single motor unit. Dr. Basmajian call them motor unit morons and according to him about 10% of the population are motor unit morons. It is possible that among patients

also you might see many who will not be able to learn this technique. May be they fall into this category of motor unit morons. As I said, all patients do not learn to inhibit their spasticity by this technique. It is worthwhile trying this technique on patients because nobody knows all the answers of inhibiting spasticity. Now I shall give you an illustration of a patient.

Mr. K., 39 year old male, was referred to us with a diagnosis of left infantile spastic hemiplegia. The date of onset was from age 5. He was on a program of physical therapy and outpatient therapy. In addition to the standard physical therapy procedures, he was also on a program of biofeedback techniques for inhibition of spasticity of the left biceps. On his initial evaluation, he had a 50 degrees inhibition in extension at his left elbow and the upper extremity was in flexor synergy. At discharge, after 6 weeks, he was out of this synergy pattern and his extension improved by 20 degrees. The techniques used were inhibition of spasticity of his biceps and recruitment of motor unit activity of his biceps. He received one-half hour sessions daily for 6 weeks.

Clonus

Many CVA's and other lesions of the pyramidal system result in clonus which causes difficulty in ambulation. The moment the effective foot is placed on the ground a rhythmical tremor of the agonists and antagonists of the ankle results. Audio-visual neuromuscular re-education techniques seem to be amenable for treatment of this problem.

The patient is prepared physically and psychologically. The electrodes are first taped to the tibialis anterior and then the foot is dorsiflexed by the therapist with the patient in the lying position. The moment clonus is evoked, the patient will see activity of the tibialis anterior on the scope and hear it on the audio. The patient is instructed to lower the noise level. This is repeated a few times, and soon the patient learns to lower the activity. Once the patient learns this technique in the lying position, the technique is now prepared in a dynamic situation. We use the Kinetron when the patient is sitting down and walking on the Kinetron. The moment the patient sees clonus, he tries to inhibit it. This process is repeated one-half

hour each day.

Incomplete lesions of the spinal cord

The patient should be evaluated to find out whether there are any muscles or groups of muscles below the lesion that are innervated and to study the amplitude of these potentials and the interference pattern. Audio-visual neuromuscular re-education techniques could also be used in those incomplete lesions where there is spasticity in muscles which could cause difficulty in ambulation. This spasticity could be inhibited using audio-visual neuromuscular re-education techniques, in addition to other therapeutic techniques.

Evaluation of patients with incomplete lesions of the spinal cord

We are all aware, due to gunshot injuries and other traumatic lesions of the spinal cord, the spinal cord is not completely severed. Therefore, the possibilities of many groups of muscles below the level of injury being viable is possible. But, due to the fact that in the acute stage of treatment, the patient is immobilized, the chances of these viable muscles being atrophied are great. When a patient is brought to a rehabilitation center, it is only correct to test for all those areas below the level of the lesion to find out the size and the nature of potentials if there are any. This is determined by placing electrodes below the level of the lesion and studying the amplitude and the duration of these motor unit potentials. As I mentioned in tape one, this is a painstaking process, and is time consuming, but it is well worthwhile, because if there are any muscles that are viable, then the therapeutic process can begin immediately. Those groups of muscles that are still innervated, should be started on a therapeutic regime rightaway. The technique of motor unit recruitment should be commenced and therapeutic exercises should be commenced for those muscles below the level of the lesion. For those patients whose lower limbs are in spasm, the technique of inhibition of spasticity are begun. Here, it should be mentioned that the technique of inhibition should commence in the lying position, then in the sitting and finally in the standing position and even in ambulation.

I shall give case illustration of two patients. Mr. P. was a 26 year old male who came to us with a T-6 lesion due to gunshot lesion.

In the early stages of his hospitalization, he had decubitus ulcers, atrophy of both lower limb muscles and contractures of both feet. However, when we started his evaluation, we found much motor unit activity below T-6 level in the abdominal musculature and we started working on those areas using the motor unit recruitment technique to increase the activity of the muscles in question. Before long, the amplitude of the potentials were near normal and so as was the interference pattern of the abdominal musculature below the lesion. The patient continued to have audio-visual neuromuscular re-education techniques, and normal therapeutic techniques for these muscles. Finally, when he left us, his lesion was like a T-11, L-1 lesion. He left us with long leg braces and a pelvic band with good sitting balance, good uppers which, of course, were normal, and was able to do much more than if he was treated in the normal way as a T-6 lesion.

The second patient, Mr. B. was a quadriplegia due to a neurofibroma at C-6 level. After surgery of the neurofibroma, he was gaining strength and power on all muscles, although his rehabilitation period took as long as 6-8 months. But, due to the early immobilization in a Minerva corset after the laminectomy, and complete bedrest, there was much atrophy of all muscles of the body and severe spasms of his adductors and his quadriceps groups of the lower limbs. As I mentioned, when we started his rehabilitation program, and was able to start ambulation, his main difficulty was adductor spasm which caused much difficulty in ambulation even in the parallel bars. Then we started the technique of inhibition of spasticity using biofeedback techniques of the adductors. The patient was treated lying down, and we found he was able to overcome his adductor spasticity in this position. But, the moment he sat down, he again had spasms. So, we continued to treat in the sitting position and later there was a carry-over in the sitting position. But, again, when he commenced walking, he continued to have spasms in walking. Then in simulated walking in the lying position, we taught him inhibition of spasticity while the motions were done in this position by a therapist. Using this technique, we were able to inhibit spasticity completely and he left the rehabilitation center using a walker with no spasticity of the lowers. It should be mentioned

as I said before, it was not only the biofeedback techniques but normal therapeutic exercises were done as a part of his rehabilitation program.

Lower motor neuron lesions

In lower motor neuron lesions, the technique of motor recruitment begins early in the therapeutic program. I think this is one technique that should be used with all peripheral nerve injuries the moment the first signs of innervation are seen by electrodiagnostic techniques, either EMG techniques or strength duration curves. We perform strength duration curves with these patients every two weeks. The moment we see signs of partial regeneration, then we commence the motor unit recruitment technique.

As I mentioned in tape one, this is one condition and this technique should be used with all patients in this category. In patients where there are signs of partial regeneration, and yet no active muscle movement, this technique is very effective. This type of patient responds better to therapy as the therapist and the patient can see the activity, although it is not seen or perceived without instrumentation.

Now, I shall give you some case illustrations. Mr. H. is a 36 year old male. In 1974, he sustained a gunshot injury to the lateral aspect of his left knee. He presented a drop foot due to paralysis of the tibialis anterior and peronei and was unable to dorsiflex and evert the foot. Marked atrophy of the tibialis anterior was seen.

Treatment. Patient referred to physical therapy for nearly 9 months. He was treated using the standard techniques of therapy - electrical stimulation, passive motions to joints, and active exercises, and given a dorsiassist. In addition to this, strength duration curves were done every 3 weeks. On the first sign of regeneration, patient was started on a program of audio-visual neuromuscular re-education.

Surface electrodes were placed on the tibialis anterior with the ground electrodes next to it. The motor unit recruitment technique was utilized for the treatment of the patient. As explained in tape one, having prepared the patient physically and psychologically, the treatment was begun. On the first evaluation, patient was able to evoke a few motor unit potentials whose amplitude was about 20-30

microvolts with a incomplete interference pattern. The technique of motor unit recruitment was done three times a week for one-half hour sessions with cross facilitation techniques, and gross motion patterns for the paralyzed limb. Before long, the patient was evoking near normal motor unit potentials with a near normal interference pattern. The atrophy of the tibialis anterior was minimized and the patient began to dorsiflex his foot.

Mr. S. was a patient with Bell's palsy who was referred to us. He had facial paralysis on the right side when we saw him the first week after the onset. A strength duration curve was done and it was found to be normal. He was started on biofeedback techniques using the recruitment of motor unit activity. The electrodes were first placed on the obicularis oris, then the buccinator and finally the frontalis muscles, and the patient was instructed to evoke as much motor unit activity as possible. He continued to increase the size of the motor unit potentials and the interference pattern became normal within two to three weeks and this patient was discharged.

It should be mentioned here that it is easy for the patient as well as the therapist in determining whether the patient is exercising the muscles in question when he is hooked onto EMG equipment.

Hysterical paralysis

Patients with hysterical paralysis show many signs and symptoms. Some are seen with spasticity and yet others are completely flaccid. Once a determination is made of hysterical paralysis and the treatment plan is designed, then biofeedback techniques has a very valuable place in the treatment of this problem. It should be mentioned that biofeedback techniques are used in combination with psychotherapy, psychological counseling and other modalities of therapy. I shall give two case illustrations of patients - one with flaccidity and one with spasticity.

Miss W. came to us with a foot problem. This patient was a 27 year old female who was an air hostess who met with an auto accident and had complete eversion of the foot with spasticity of the peronei. The foot was everted about 50 degrees from the normal, and she was ambulating holding the foot in this position. The initial diagnosis

was contusion of S-1, S-2, low back pain and spasticity of the peronei with eversion of the foot. She had this problem for seven months and had consulted many physicians all over the country, and was advised laminectomy and orthopedic surgery for the foot. However, she refused this type of surgery and came to our institution for rehabilitation. When I evaluated this patient, I saw motor unit activity on the peronei at rest and this group of muscles were in severe spasms. I explained to the patient what was expected of her and what would be seen on the scope when she completely relaxed. The electrodes were placed on the peronei and when the technique of inhibition of spasticity was begun, the patient was able to completely relax the peronei and even bring the foot to the mid-position, actively, although she was in severe pain. The pain was due to the fact that the foot was held in that position and the joint capsules were in contracture. The patient was able to bring the foot to the neutral position using biofeedback techniques on her own volition. However, at the end of treatment, the foot went back to the valgus position as before. We continued to use this technique everyday, sometimes twice a day for three weeks. In addition to that, she had whirlpool baths, therapeutic exercises, ambulation training and isokinetics. Before long, she was able to hold the foot even without biofeedback techniques in the neutral position and even to do dorsiflexion and plantar flexion. She was discharged four weeks after admission with a portable unit to practice relaxation techniques of the peronei. We can now report that she is normal and able to ambulate and she is back at work.

The second patient was a 31 year old female with a past history of recurrent CVA's. Her admission diagnosis was right hemiparesis secondary to CVA with flaccidity of both extremities of the right side. During the first episode of CVA when she was referred to us, she spent six weeks in the rehabilitation process with us and was discharged with a long leg brace and with a muscle power of trace to poor in the lower extremity. However, at the end of six months, she completely recovered. The second time, she was again diagnosed as CVA and referred to our institution. Within three to four days, there was a complete return of all power and motion of the right upper extremity, but the right

lower extremity continued to be in complete flaccidity with no motion at all. We commenced biofeedback techniques for this patient using the motor unit recruitment technique. Electrodes were placed on the quadriceps and the therapist explained to the patient what was expected of her. The technique we used was motor unit recruitment. The patient was in the sitting position with both feet hanging on the side of the bed. The therapist extended her extremity and told the patient that he will let go his hand so that the leg would fall down if the patient did not contract those muscles. This was done a few times and as the patient could not contract her quadriceps, she was not able to hold that position. Eventually, the patient began to tighten the quadriceps and when she did this, one could see a few motor unit potentials on the scope and hear the noise on the audio. This reinforced the patient and within minutes, the patient was firing huge motor units with near normal interference patterns. This technique was continued with all the other muscles of the lower extremity, the dorsiflexors, the plantar flexors, the evertors and within a half hour, she was able to fire all motor units in all the musculature of that limb. We then started ambulating her, and she was able to hold the knee in place. However, she continued to ambulate with a drop foot for a few days. Biofeedback techniques were continued for a few more days and the patient thereafter continued to do only therapeutic exercises.

If we did not institute biofeedback training at that time, I am sure she would have just continued to be in the rehabilitation institute like the first time and her return would have been much more slower. It should be mentioned here that biofeedback techniques in patients with hysterical paralysis is only a vehicle to get to the point where the patient accepts her problem and goes along with the therapist to get better.

Muscle spasms of unknown etiology

These patients are in severe pain due to the vicious cycle of muscle spasm, pain and more muscle spasm. Sometimes, this type of patient does not respond to drugs and continues to be in this vicious cycle. We had a few patients referred to us because of this problem and we found biofeedback techniques were effective to alleviate this

problem.

The first patient Mrs. S. was a female who was a paraplegic five years ago. Her problem was severe muscle spasm of both sternocleidomastoid muscles causing pain which did not respond to any of the drugs the physicians prescribed. She was referred to us for biofeedback techniques. In addition to the biofeedback techniques, we also gave her hot packs to help relaxation. The technique was one of general relaxation. The electrodes were applied first on one sternocleidomastoid muscle and then on the other. When the patient was evaluated, we could see huge motor unit activity in her sternocleidomastoid muscle while even at rest. The patient was prepared physically and psychologically and the treatment procedure explained to her. First the electrodes were applied on the right sternocleidomastoid muscle, and the patient was instructed to move her neck to the left. One could now see more activity on the scope and hear it on the audio. The patient was then instructed to bring the neck to the mid-position and lower the noise completely. Soon she learned to do this. The same procedure was done with the left sternocleidomastoid muscle. She learnt to relax both muscles in the mid-position with the help of the equipment. This procedure was also tried without the equipment. She was in therapy for a few days, and at each therapy session, in addition to this technique, she was also taught breathing exercise and general relaxation techniques. Within five days, she was able to control her spasms and was discharged from the hospital. However, this patient was re-admitted again within a few months for the same problem. This time, in addition to treating her in the hospital as before, she was given a portable unit to take home with her. She practices this technique twice daily at home for one half hour each time. She has not returned to the hospital with this problem ever since.

The second patient was a patient with osteogenita imperfecta. Her problem was severe muscle spasm in the paraspinal muscles of the back which was causing her severe pain. She was not responding to analgesics and the physicians referred her for general relaxation techniques. When she came to us, we evaluated her and found the paraspinal muscles in severe spasm even at rest. The patient was begun on therapy in the

prone position with electrodes on one paraspinal group and then on the other. The technique used was relaxation of her spasms. The electrodes were on one paraspinal group with the ground close to it, and the patient was in prone position and the patient could see and hear the noise. She was instructed to raise her head and shoulders and come back to the neutral position and then lower the noise completely. Within minutes the patient learned the technique. The carry-over was slow but within a couple of days, the patient soon learnt to reduce her spasms and even control her pain.

This type of patient is referred to us because they could not control the spasms and hence the pain. The ideal protocol of treatment for these patients as in-patients, is to be seen twice a day for 30 minutes of training each time. In addition to this, both these patients were taught Jacobson's relaxation techniques and general relaxation of all muscle groups.

Spasmodic torticollis

Spasmodic torticollis is a problem of unknown etiology. For many years it was thought of as a problem in the basal ganglia. However, now this theory has been discarded. We have seen about 10-11 patients with spasmodic torticollis. Our experience shows that every patient differs and, therefore, the strategy to be used on every patient depends on his own particular problem. In general, each patient should be evaluated not only for the activity of the sternocleidomastoid muscles, but also of the upper trapezius and the paraspinal muscles. They should be evaluated during all the motions for each muscle. Having evaluated, then a program is designed for each patient. Our success rate, so far, is not as good as what is reported elsewhere in the country. But we see a 20-30% success rate with our group. Some of the patients, in addition to biofeedback techniques, also are in psychological counseling.

We see a few types of movement disorders with these patients:

- (1) those patients whose sternocleidomastoid muscle on one side is hypertrophied and in spasm with the head turning to the opposite side is called the classical type; (2) those patients, in addition to problem (1), also have atrophy of the sternocleidomastoid muscle on the other side. Most patients will present both these problems; (3) some patients

will present hypertrophy and spasm of one sternocleidomastoid muscle with head turning to the opposite side. In addition to this, the sternocleidomastoid muscle on the other side will be co-contracting. That is when the head turns to the side opposite the hypertrophied side, and the sternocleidomastoid muscle on the atrophied side will also work with the hypertrophied side to rotate the neck; (4) some patients, in addition to the classical picture, will also have spasms of the trapezius and the paraspinal muscles.

All patients, inspite of spasmodic torticollis, could continue to work in their chosen field if they were able to release their spasms and bring the neck back to the mid-position. All these patients in an anxiety producing environment, are unable to bring the neck back to the mid-position smoothly, but only do that in two or three stages in a jerky fashion. Although many of the patients we treated continued to have their problems, i.e. all who had no structural involvement, learnt to release his spasms and bring the neck back to the midline in a smooth movement.

Let us discuss the problems of a patient we treated and the strategies used to treat him.

Each patient is initially evaluated and a treatment plan designed to suit the individual needs.

Mr. O., a 56 year old male, had spasmodic torticollis for two years. He was a salesman, and was treated by many other physicians and therapists before seeing us. His main difficulty was that he was unable to drive his car as his neck turned to the side while driving. He had left spasmodic torticollis with spasm of the right sternocleidomastoid muscle, with the neck turning to the left.

On evaluation we found (1) the right sternocleidomastoid muscle was hypertrophied and the neck rotated to the left; (2) right sternocleidomastoid muscle in severe spasm; (3) left sternocleidomastoid muscle atrophied; (4) left sternocleidomastoid muscle was co-contracting with the right to turn the neck to the left; (5) when the patient turned the neck to the right, the left sternocleidomastoid muscle was firing a few motor units of very small amplitude; and (6) when the neck was turned to the left, he was unable to bring the neck back to the midline

smoothly, instead he brought it to the mid-position in a jerky manner.

The treatment consisted of:

1. Inhibition of spasms in the right sternocleidomastoid muscle.
2. Recruitment of motor unit activity of left sternocleidomastoid muscle.
3. Isometric exercises for left sternocleidomastoid muscle.
4. Re-education of the left sternocleidomastoid muscle to rotate the neck to the right side.
5. Inhibition of left sternocleidomastoid whilst neck turned to left side.
6. Teaching patient recruitment of motor unit activity whilst turning right sternocleidomastoid muscle to left and inhibition when he brought the neck back to midline.
7. Jacobson's relaxation techniques to practice at home.

Within 12 treatments, he was able to bring the neck back to midline smoothly. His atrophy of the left sternocleidomastoid muscle was normal and the left sternocleidomastoid muscle learnt its normal motion. When he stopped his treatment, he was able to drive his car although his condition was not resolved entirely.

Movement mosaics: A simulation game for
prospective adapted physical educators of retarded children

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Introduction*

Education today is being scrutinized as closely as politics. This examination is based on educators' accountability to students, taxpayers, and other professionals within education. This means that educators and politicians must show concrete facts of their successes and reasons for their failures. Also because of this scrutiny, new methods in education, such as the use of instructional systems technology, must be tested and validated with the results made public.

The use of innovative instructional systems, ranging from video tapes to programmed instruction is practiced currently at all levels of education. One specific type of instructional system is the simulation game. A simulation game can be used as an intervening teaching aid and can enable the user to simulate or model his play and his decisions after a real-life situation. An example is the game of Ghetto in which students try to understand better the poor people and some of the problems that confront them (Livingston, 1972).

Simulation games are used in the elementary and secondary schools and are beginning to be used as an intervening teaching aid in the preparation of future teachers (Moline, 1973; Twelker, 1967). Since one facet of physical education is concerned with teaching through games, it would seem logical to develop a simulation game to aid prospective teachers in teaching physical education activities to children. Carried one step further, a simulation game used in planning activities for a specific population would be beneficial to prospective teachers and to prospective students. This would be true,

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especially if the student population normally were excluded from the "typical" realm of educational experiences of prospective teachers. Moderately retarded children are examples of a population whose needs and interests are often ignored in the professional preparation of prospective teachers. The lack of adequate planning for normal and retarded children is further qualified by Morine when she states that "the paradox of planning skills is that it is an area of the teacher education curriculum for which almost no planning has been done".

One such application of instructional systems to the field of physical education would be a simulation game to aid in teaching prospective teachers to understand the needs, interests, and characteristics of moderately retarded children in order to plan, select, and adapt physical education activities for them. Through Movement Mosaics the prospective adapted physical education teacher would have access to a source of media, the simulation game, which now is available in many disciplines in the educational spectrum. The simulation game Movement Mosaics would be used to train future professionals, rather than as a resource game for teachers to use in the classroom. In time, one may see a variety of instructional packages for teacher education training stored in one location just as there is now a National Center on Education Media and Materials for those who teach handicapped children (Belland, 1973).

Since educators are to be held accountable for what and how they teach children, they must attain competencies in their areas of expertise. In this study the game Movement Mosaics was developed to simulate situations that would necessitate the prospective physical education teacher making some concrete decisions in planning, selecting and adapting physical activity for the moderately retarded child. Through gaining experience in decision making, the prospective teacher should become more technically competent (Bowles, 1973). By becoming more technically competent, the prospective teacher should be able to face a variety of situations with more confidence and hopefully with more success. In the end it will be the child who will benefit.

Need and significance

The idea for this study was formed when the look of shock on the faces of undergraduate practicum students was noted the first time they came to observe moderately retarded children (C.A. 2-18) participating in adapted physical education classes. It was obvious by their comments that the practicum students were surprised to see these children in any kind of organized, purposeful activity. The moderately and severely retarded youngsters were engaged in activities from crawling through hula hoops to beginning square dance patterns. Later, as the practicum students participated in the teaching, it also was apparent that they had difficulty in planning, selecting, and adapting activities for these children. These types of reactions, fear, confusion, and lack of skills in program planning in adapted physical education encouraged the investigator to seek an intervening teaching aid, that would benefit prospective teachers as well as the children.

The use of a simulation game as an intervening teaching aid was thought to be an innovative approach in helping to prepare prospective teachers to understand moderately retarded children and to teach adapted physical education to these children. The selection and use of a simulation game was considered also because it involved the use of a systems approach, a popular educational tool. Finally, the use of a simulation game was considered because it was used in other disciplines, but seemingly not yet applied to the field of Adapted Physical Education.

Methods and procedures

A total of 68 subjects participated in the study. The subjects were undergraduate students enrolled in three adapted physical education classes in the School of Health, Physical Education, and Recreation at Indiana University, during the 1975-76 spring semester. Two of the three intact classes were combined to form Group B, while one large class formed Group A. Members of each group were matched on the basis of whether or not they had experienced previous contact

with moderately retarded children in an adapted physical education program.

Group A was the experimental group (Appendix A). These subjects played the simulation game Movement Mosaics during the first session. Immediately after playing the simulation game the subjects received a post-test and completed a game evaluation form. One week later this group received a second testing on the same material. Group B was the control group. During the first session these subjects received only a test. One week later these subjects played Movement Mosaics. Immediately after playing the simulation game the subjects received a post-test and completed a game evaluation form (Appendix B). Test material for the second session was the same as for the first session. Having met the statistical assumptions for two group comparisons, the data were analyzed using the two dimensional analysis of variance technique with repeated measures on one factor. The test for simple effects was also performed on the data.

The development of the game questions was the critical point of this study. Content validation of each question and concept by a jury of experts was necessary to assure accuracy and suitability of information. By going through two phases of content validation, sound questions and concepts were able to be presented. The first phase used on-campus experts in adapted physical education and special education to examine the questions before they were sent to a jury of experts with the same make-up as the mini-jury. In addition, a tests and measurements person examined the questions. Phase two of the content validation was the use of the critiques by the jury of experts. In this manner the validity of the game questions was assured for the study.

There were three, progressive, levels in the simulation game. The questions for Level I were based on 10 concepts dealing with the needs, interests, and characteristics of moderately retarded children. These concepts were formulated from research of current texts, articles, and papers in special education. The next step involved writing four questions for each concept. In this manner, the player of the game had more than one chance to reinforce learning of a concept.

The questions for Level II dealt with selection and adaptation of physical activity for the moderately retarded child. Thus, the player progressed from Level I to Level II play. Once again, the questions were based on current papers, texts, and articles in the field of adapted physical education.

The third level of play was designed to be played with "criteria sheets" developed by the author. The criteria listed were important elements in lesson planning in adapted physical education.

Summary and findings

The following is a summary of the results of the statistical analyses.

1. A statistical difference was not found between scores at the two test times for questions in subscale one, which dealt with the needs, interests, and characteristics of moderately retarded children. However, a statistical difference was found between groups and in the interaction between groups and test times in subscale one.

2. A significant difference was found between scores at the two test times on questions in subscale two which dealt with the selection and adaptation of physical activity for moderately retarded children. Statistical significance was also attained in the interaction between groups and test times but not between groups.

3. A significant difference was found between test time, between groups, and in the interaction between groups and test times for total scores.

4. A significant difference was not found in Group A between scores at test time I and test time II.

5. A significant difference was not found between the scores of Group A at test time I and the scores of Group B at test time II.

Conclusions

Within the limits of the study the following conclusions can be drawn regarding the use of the simulation game Movement Mosaics as an

intervening teaching aid in undergraduate adapted physical education classes.

1. The use of a simulation game as an intervening teaching aid is accepted by undergraduate students enrolled in adapted physical education classes.

2. The simulation game is effective in teaching students about needs, interests, and characteristics of moderately retarded children.

3. Knowledges learned from the simulation game remain relatively stable.

4. The simulation game can be an effective teaching device.

5. The simulation game can be effective as a self-contained game. The instructor can interact freely with one or several groups.

Recommendations

The following are recommendations for further research:

1. A replication of this study using a third group of subjects receiving no treatment (a true control group) would help clarify further the findings of this study.

2. Although the simulation game was designed for undergraduate physical education majors, replication of this study with subjects other than physical education or special education majors would allow assessment of the effectiveness of the game in teaching selection and adaptation of physical activity for moderately retarded children.

3. A different timetable with longer periods between immediate and later post-tests would be desirable in order to measure long term retention.

4. Statistical validation of all the game questions in addition to the content validation conducted for this study, would be desirable.

5. A different experimental design might be considered in which the possible sensitization of the subjects by the pretest is controlled.

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Appendix A

	Week I	Week II
Group A (R)	$X_1 \ O_1$	O_2
Group B (R)	O_3	$X_2 \ O_4$

R = random assignment of subjects;

X_1 = treatment, experimental subjects played Movement Mosaics;

O_1 = post-test measure, immediately after treatment.

O_3 = post-test measure to control group for X_1 and pretest measure for X_2 replication of treatment;

O_2 = post-test measure one week after treatment;

X_2 = treatment, control subjects played Movement Mosaics;

O_4 = post-test measure immediately after treatment.

(Experimental design to evaluate the effectiveness of the simulation game, Movement Mosaics).

Appendix B

Game evaluation form percentages

	SA-A	U	D-SD
1. This instructional game is worthless	4.4	11.8	84.8
2. This instructional game was fun	64.0	25.0	11.0
3. It would be easier to learn this information from books than from this game	8.8	17.6	73.6
4. This game helped me to learn	90.0	74.0	2.9
5. This game was too complicated	5.9	8.8	85.3
6. This game should be played toward the end of the course	26.5	26.5	47.0
7. The rules of the game were fair	88.3	7.3	4.4
8. The games became boring	64.7	16.2	19.1
9. The game was slow moving	36.8	16.0	47.0
10. The game distorted information	7.3	25.0	67.7
11. The game gave everyone a chance to participate	95.6	1.5	2.9
12. The game was challenging	73.5	16.2	10.3
13. The objectives of this game were understandable	83.8	10.3	5.9
14. The game met its objectives	73.6	23.5	2.9

SA-A = strongly agree - agree; U = undecided; D-SD = disagree - strongly disagree.

Null hypotheses

Below are the specific null hypotheses for evaluation of the simulation game Movement Mosaics as an intervening teaching aid at the .05 level of significance.

Hypothesis (H_1): there will be no significant difference in the scores which reflect knowledge of needs, interests, and characteristics of moderately retarded children between those prospective teachers who have played the simulation game Movement Mosaics and those prospective teachers who have not yet played the simulation game.

Hypothesis (H_2): there will be no significant difference in the scores which reflect ability to select and adapt physical activities for moderately retarded children between those prospective teachers who have played the simulation game Movement Mosaics and those prospective teachers who have not yet played the simulation game.

Hypothesis (H_3): there will be no significant difference reflected in total scores between those prospective teachers who receive a pretest in week one and those prospective teachers who do not receive a pretest before playing the game.

Hypothesis (H_4): there will be no significant difference in knowledge exhibited by those prospective teachers in treatment Group A who receive the simulation game-test treatment during the first week and are retested one week later.

Hypothesis (H_5): there will be no significant differences between the total scores of the prospective teachers in Group A who play the simulation game and are immediately assessed during the first session and the total scores of those prospective teachers immediately assessed after play one week later under the same circumstances.

Les effets d'un traitement de soins à domicile
seul et avec PIPE (Prone Immersion Physical Exercise)
ou traitement d'exercice traditionnel
chez les insuffisants respiratoires

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La maladie broncho-pulmonaire obstructive et chronique (MBPOC) est le terme collectif utilisé pour un syndrome de trois maladies souvent trouvées ensemble avec des interrelations très complexes.

Les trois maladies de ce syndrome triade sont: l'asthme, la bronchite chronique, et l'emphysème. Le facteur causal principal dans 80% des cas est la cigarette. Les symptômes principaux incluent la dyspnée à l'effort, une toux chronique, une production de sécrétions claires ou infectées, et dans les derniers stades, une perte d'élasticité pulmonaire accompagnée par un collapsus des voies aériennes périphériques d'où emprisonnement de l'air dans les poumons, d'où le terme grec emphysème qui signifie plein air.

Entre les années 1920 et 1930, Hoffbauer, en Allemagne, MacMachon en Angleterre et Cournand à New York, ont recommandé l'entraînement physique pour les insuffisants respiratoires. Plus récemment, Barach à New York, Haas et Cardon à New York University et Miller à Dallas ont utilisé la marche et la bicyclette ergométrique avec ou sans oxygène, comme moyen d'entraîner les insuffisants respiratoires.

La conclusion générale à tirer de la plupart de ces recherches réalisées à l'aide d'exercices effectués en position verticale est une amélioration subjective de la part du sujet accompagnée d'une bradycardie à l'entraînement, d'une augmentation dans la capacité de travail physique expliquée par une augmentation de la consommation maximale d'oxygène et d'un rendement biomécanique meilleur pour ces malades. Curieusement, les améliorations subjectives et fonctionnelles n'étaient jamais associées à une amélioration de la fonction pulmonaire.

Même chez l'individu en parfaite santé, la ventilation-perfusion pulmonaire peut être améliorée simplement par le changement d'une position verticale à une position horizontale. Les obstructions dans les petites voies aériennes et l'emprisonnement de l'air qui accompagne le syndrome MBPOC peuvent être expliqués comme une perturbation de la relation entre la ventilation-perfusion pulmonaire. Une hypothèse fondamentale dans ce projet était que la ventilation-perfusion chez le malade souffrant de MBPOC peut être améliorée en le plaçant dans une position horizontale pour ses exercices thérapeutiques. Une deuxième hypothèse était que le diaphragme libéré des forces de gravité pouvait se déplacer plus librement de gauche à droite et donc pouvait augmenter sa fonction dans une position horizontale.

La possibilité d'entraîner un groupe de malades pendant une période prolongée a été vérifiée au cours d'un projet pilote et les résultats de ce projet ont été publiés le mois dernier dans le *Scandinavian Journal of Rehabilitation Medicine*.

Le but de cette recherche était de vérifier si les exercices PIPE (physiothérapie intensive, position étendue) étaient vraiment supérieurs aux programmes d'exercices traditionnels utilisés par d'autres chercheurs en ce domaine.

Sujets

Dix-huit malades, 11 femmes et 7 hommes, souffrant de MBPOC, mais sans indication sérieuse de maladie cardiaque, ont été divisés aléatoirement en trois groupes égaux. Le Groupe 1 a servi de groupe-témoin, les Groupes 2 et 3 se sont entraînés à une moyenne de 75% de leur capacité maximale, trois fois par semaine pendant six mois. Avant et après la période d'entraînement, la fonction pulmonaire des sujets était mesurée par la spirométrie et leur capacité fonctionnelle était déterminée par une épreuve progressive à l'effort sur la bicyclette ergométrique. Voici les principaux résultats.

En terme de capacité physique au travail, le Groupe PIPE est passé en moyenne de 200 kgm/m'min jusqu'à 325 kgm/m'min, c'est-à-dire une amélioration de 62.5%. Le groupe bicyclette ergométrique est passé en moyenne de 133 kgm/m'min jusqu'à 225 kgm/m'min, c'est-à-dire une amélioration de 69% qui peut être expliquée par une valeur absolue inférieure

au départ et par la possibilité d'une spécificité d'entraînement sur la bicyclette. Le groupe-témoin est passé de 213 kgm/m²/min à 192 kgm/m²/min, c'est-à-dire une diminution de 10% dans leur capacité physique au travail.

La consommation maximale d'oxygène dans le groupe PIPE a augmenté de 743 ml/min jusqu'à 918 ml/O₂/min, ce qui correspond à une amélioration de 24%. Le groupe qui s'est entraîné sur les bicyclettes ergométriques a augmenté de 574 ml/min jusqu'à 693 ml/min, ce qui correspond à une amélioration de 22%. Le groupe-témoin a diminué de 743 ml/min jusqu'à 686 ml/min, ce qui correspond à une diminution de 8%.

Le volume ventilatoire BTPS au $\dot{V}O_2$ maximum a augmenté de 15% chez le groupe PIPE, de 5% chez le groupe d'exercice à bicyclette ergométrique, et a diminué de 9% chez le groupe-témoin.

La fréquence respiratoire a diminué approximativement de 8% chez le groupe PIPE, de 3% chez le groupe à bicyclette ergométrique et a augmenté de 2% chez le groupe-témoin.

Le volume courant qui est un moyen de déterminer le rendement du système respiratoire, a augmenté de 41% chez le groupe PIPE, de 9% chez le groupe à bicyclette ergométrique et a diminué de 11% chez le groupe-témoin.

Quant à la fonction respiratoire, la capacité vitale a augmenté de 1483 ml à 1901 ml chez le groupe PIPE, ce qui correspond à une amélioration de 28.2%. Le groupe à bicyclette ergométrique s'est amélioré de 3.9% mais cette différence n'est pas significative. La capacité vitale chez le groupe-témoin a diminué de 1638 ml à 1490 ml, ce qui correspond à une perte d'environ 9%.

Le volume expiratoire minuté dans une seconde ou F_{EV_1} a augmenté de 550 ml à 668 ml, ce qui correspond à une augmentation de 21% chez le groupe PIPE, le groupe bicyclette ergométrique est demeuré inchangé, 611 par rapport à 584 et le groupe-témoin a diminué en moyenne de 606 ml à 547 ml, ce qui correspond à une perte d'environ 9%.

Les fréquences cardiaques maximales avant et après l'entraînement n'étaient pas significativement différentes. Donc, on peut conclure que ces changements sont vraiment physiologiques et ne sont pas simplement un artéfact dû aux habitudes d'un chercheur versus les sujets.

L'analyse de ces résultats est loin d'être complétée. Il est évident que PIPE est la méthode de choix pour la réadaptation des insuffisants respiratoires.

Physical fitness and psychomotor performance
of mentally retarded children

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The services of non-institutional care for the mentally retarded are being planned and improved in Finland. For the mentally retarded, non-institutional care means a wider social participation. It can enable them to cope with the activities of daily life both at work and during their leisure time. It has been estimated that more than 50% of all mentally retarded can hold gainful employment following education and rehabilitation.

Heretofore, research in physical fitness and psychomotor performance has not properly addressed the problem of "practical" education for the mentally retarded. Investigations have focused on the mildly retarded, perhaps because it is easier to use the standardized tests for normals on this population. The result is that the more severely retarded have been ignored and few tests specifically designed or adapted for the mentally retarded are available. Consequently, the development of physical education and leisure time activities has been routinely ignored in the services of non-institutional and institutional care.

This study employs new and adapted testing procedures to examine the physical fitness and psychomotor performance of mentally retarded children, with special attention to the needs and health risks of occupational work and leisure time activity.

Subjects

The investigation focused on 11 to 16 year old mildly or moderately mentally retarded girls and boys from the area of central Finland. All were in institutional or non-institutional care and had no movement disturbances or psychoses. Eighty-two percent (N = 77) of this

population were tested. The control group consisted of 195 school children of the same age and from the same geographic area.

Methods

Most of the standard tests for measuring physical fitness and motor skills may be adapted for the mildly disabled in general and also for the mildly mentally retarded. However, a problem arises when one wants to measure the physical fitness and motor skills of the more severely handicapped. In order to measure these capabilities and characteristics of moderately or severely mentally retarded persons the tests should be modified to meet the performance level of this particular group.

In selecting the tests and methods for this study, careful attention was given to factors which, according to earlier research, are related to job performance, health and leisure time activities. The nature of work in sheltered workshops for the mentally retarded was also considered.

Of course, the mentally retarded have greater opportunities for employment in manual labor positions. This type of work requires a moderate level of physical fitness. Therefore, strength, running speed and endurance were investigated, as all are important to general physical fitness and to success in work involving lifting or carrying. Descriptions of these tests are given in Section A of the Appendix. Measuring endurance of mentally retarded requires special arrangements. Problems arise in the areas of coordination, rhythm, understanding, familiarity and motivation. In preliminary trials, the 300 meter run (Fait, 1972; Hayden, 1964) proved most suitable for this population. In a like manner, the 25 meter run (Fait, 1972) was chosen to measure running speed.

To investigate motor performance, tests of gross coordination, balance, exactness of throwing, manual skill, and reaction time were administered. Descriptions of these tests are given in Section B of the Appendix. Lifting, carrying and moving, if performed quickly require gross coordination and balance. Another reason for choosing

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results.

Results

The reliability of the methods was determined by repeating the measurements after one week. The reliability coefficients varied in the group of mentally retarded from .73 to .98 and in the reference group from .84 to .98. Therefore, the stability of the test can be considered as relatively good. Also the high correlations and communalities between the variables suggest good reliability. The mentally retarded were shorter and more obese than the controls. There were no differences in secondary sexual development.

In tests of physical fitness, the retarded children scored lower than the controls, which could be expected. Of particular interest, however, was the relative ability of the various tests to discriminate between the two groups. In this respect, the groups differed most in endurance and muscular strength of the legs, and least in manual and abdominal muscular strength.

The mentally retarded were also less successful in tests of psychomotor performance, compared to controls. But here the difference between the two groups was more profound, with controls scoring 2 to 3 times higher in tests of balance, reaction time, and some tests of manual skills.

All children were assigned to one of two groups, more independent or less independent, on the basis of scores attained on a modified scale for adaptive behavior (Nihira, Foster, & Spencer, 1968). One might suppose that physical fitness and psychomotor performance are significant factors in an individual's ability to be independent. Discriminant function analysis supports this hypothesis. After IQ and age, manual skills, balance and gross coordination were significant contributors to independence. Muscular strength also has some slight significance, but running speed and endurance were not important in this respect.

While the performances of the mentally retarded in the area of physical fitness and psychomotor performance were significantly poorer

than those of the reference group, more attention should be paid to the fact that almost all of the mentally retarded could perform the test tasks. Most of them could throw a ball, skip, and run, which gives important information for the planning of physical activities. Most of them also could perform the tests of manual skill and gross coordination, which indicates that there exists at least a physical capacity to work.

On the basis of this investigation, most mildly and moderately mentally retarded children appear to have the capacity to satisfy the needs of work and leisure time in non-institutional care. The results can be used to plan school, work and leisure time activities for the mentally retarded.

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APPENDIX

Section A

Tests of physical fitness

1. 300 meter run

The test measures anaerobic and aerobic capacity.

Equipment: A 50 m distance on a track with two persons marking the ends which also are the turning points. An assistant runs with and motivates the subject.

Position: The subject starts from a standing position behind the starting line.

Instructions: Run to the person over there, around him and back again as fast as you can. Repeat this run three times without stopping.

Measurement of performance: The 300 m run is performed once and the time recorded to the nearest second.

2. Sit up

The test measures the dynamic strength of the abdominal muscles.

Position: The subject lies on his back on a 2 cm thick superlon-plate, knees bent at an angle of 90° and hands resting on the abdomen with fingers interlocked. An assistant gives support at the ankles.

Instructions: Sit up straight and lie down again. Be sure that your head touches the floor. Repeat smoothly and without stopping as many times as you can. During the performance you must not support yourself with your elbows.

Measurement of performance: The numbers of sit ups are counted up to 30.

3. 25 meter run

The test measures running speed.

Equipment: 25 m track.

Position: The subject starts from a standing position, leaning forward with the front foot behind the starting line.

Instructions: Run as fast as you can to the person standing over there (the person is standing 10 m after the 25 m track).

Measurement of performance: The 25 m run is measured to within 0.1 sec. The subject is allowed to run twice and the better result is recorded. An assistant accompanies and motivates the subject.

4. Forward flexion of trunk

The test measures the isometric muscle strength of the abdominal muscles.

Equipment: A strain-gauge transducer connected to a recorder, and two wooden plates connected by hinges and fixed on a stationary base. One plate is horizontal and the other is raised at an angle of 30° to the horizontal one. Two straps, the position of which can be adjusted, are connected to the plates. Total error of the equipment can be approximated from full scale (100 kp) $A = 0.75\% + 2 \times 0.5\% = 1.75\%$.

Position: The subject is in a half-sitting position with the pelvis held where the plates join. The other strap connected to the strain-gauge transducer at the back of the subject is tightened around the chest of the subject. The subject's knees are bent at an angle of 90° and his feet are on the plate. An assistant supports his ankles and knees. His hands rest on the abdomen with fingers interlocked.

Instructions: Bend forwards against the strap as smoothly and strongly as you can until you are told to relax.

Measurement of performance: The performance is repeated three times at intervals of 15 sec. The subjects are told to relax between performances. The performances are registered in kiloponds and the best performance is recorded.

5. Backward extension of trunk

The test measures the isometric muscle strength of the back muscles.

Equipment: The same as in measuring forward flexion of trunk. One plate is in a horizontal position and the other one is lowered at an angle of 30° to the horizontal one.

Position: The subject lies prone with the pelvis at the joint of the plates and with the upper part of the body bent downward. One of the straps holds the chest and the height of the axilla and the other at the height of the spina iliaca. An assistant supports the ankles.

Instructions: Bend the upper part of your body backwards against the strap as smoothly and strongly as you can until you are told to relax.

Measurement of performance: The same as in measuring the forward flexion of the trunk.

6. Leg extension (both legs)

The test measures the isometric muscle strength of the leg extensors.

Equipment: A dynamometer measuring the extension force of the legs.

Position: The subject is in a half-sitting position, knees bent at an angle of 90° and feet placed on a foot plate.

Instructions: You are to extend your legs as strongly as you can against the load.

Measurement of performance: The maximal load which the subject can make move is recorded in kiloponds.

7. Elbow flexion

The test measures the isometric muscle strength of the elbow flexors.

Equipment: The same as in measuring forward flexion of trunk. The plates are in a horizontal position.

Position: The subject is sitting erect holding the strap connected to the transducer. The elbow is flexed at an angle of 90° with the forearm on the plate in the middle position.

Instructions: Bend your arm as smoothly and strongly as you can until you are told to relax.

Measurement of performance: The same as in measuring the forward flexion of the trunk.

Section B

Tests of psychomotor performance

1. Hopping on one leg

The test measures the ability to reach and maintain balance in hopping.

Instructions: Hop forward on one leg until you are told to stop.

Measurement of performance: 3 points: at least 3 correct hops;
2 points: 1-2 correct hops; 1 point: hops once, but loses balance;
0 point: unable to hop.

2. Walking on balance boards

The test measures dynamic balance.

Equipment: 3 balance boards, 2.75 m long, 5 cm high and 6 cm, 4.5 cm and 3 cm wide.

Instructions: Walk on each board from one end to the other without touching the floor except when turning at the end of the board. If you fail you can start from the beginning again. You have four trials on on each board.

Measurement of performance: The number of steps taken on the board is counted. The total score is calculated on the bases of the three best performances on each board. The maximum score for each performance is 8, which can be achieved either by walking on the board from end to end without mistakes or by taking 8 steps on the board (Eggert & Kiphard, 1972).

3. Standing on one foot

The test measures static balance.

Instructions: Place your hands on your hips, lift one leg, and place your foot inside the knee of your other leg. Keep this position as long as you can.

Measurement of performance: Standing time is recorded from when the subject reaches the correct standing position to when the subject loses balance.

4. Carrying boxes

The test measures gross coordination in lifting and carrying.

Equipment: 10 cardboard boxes (22 cm x 31 cm x 23 cm) weighing 1 kg each.

Position: There are two marked lines at a distance of 4 m. The boxes are lined up behind one of the lines and are to be carried and lined up behind the other. The subject is to start from one end of the row.

Instructions: Take hold of the boxes one by one with both hands and carry them to the other side and place them in a row behind the line. Do it as fast as you can but do not run.

Measurement of performance: Total performance time is recorded in seconds. The better one of the two trials is recorded.

5. Piling boxes

The test measures gross coordination in lifting, transferring and piling.

Equipment: Five cardboard boxes (22 cm x 31 cm x 23 cm) weighing 1 kg each.

Position: The piled boxes are placed in front of the subject obliquely to the left and are to be transferred and piled 1 m obliquely to the right.

Instructions: Take hold of the boxes one by one with both hands and pile them onto the marked place on the other side. Do it as fast as possible.

Measurement of performance: The total time of performance is registered to within 0.1 sec.

6. Throwing a ball

The test measures the coordination of hand and eye and exactness in throwing a ball.

Equipment: 10 tennisballs and a basket (height 52 cm, diameter 37 cm).

Position: The subject stands behind a line 2 m away from the basket.

Instructions: Throw the balls one by one with your better hand into the basket. Concentrate on each performance.

Measurement of performance: The test is performed once and each successful throw gives one point.

7. Moving large beads over

The test measures the ability to grip a small object, to move it from one place to another and to release it, with only the index finger and the thumb of one hand.

Equipment: Two round plastic bowls (diameter 14 cm) placed at a distance of 5 cm from one another side by side, and 10 wooden beads with a diameter of 13 mm. For right-handed persons the beads are in the left-hand bowl at commencement, for left-handed persons in the right-hand bowl.

Instructions: One of the plastic bowls in front of you contains 10 beads and the other bowl is empty. Your task is to put the beads one by one into the other bowl as fast as you can.

8. Moving small beads over

The test is similar to the test "moving large beads over". The beads have a diameter of 7 mm.

9. Threading a pencil

This test measures the coordination of the hands and the ability to thread with one hand and receive with the other.

Equipment: A wooden cylinder mounted vertically on a stand (the diameter of the cylinder 5.7 cm) with a hole of approximately 8 mm diameter drilled horizontally through the cylinder, 10 unsharpened pencils and two shallow cardboard boxes for the pencils (one box on each side of the cylinder). At commencement, the pencils are in the box on the side of the dominant hand.

Instructions: In front of you there is a wooden cylinder with a hole in it. On one side of the cylinder there is a box with 10 pencils while the box on the other side is empty. You are to take one pencil at a time, thread it through the hole in the cylinder and put it in the other cardboard box as quickly as you can.

10. Putting the cap on ball-point pens

This test measures the cooperation of the hands, the ability to grip and attach objects with both hands.

Equipment: Ten ball-point pens and the caps belonging to them and two shallow cardboard boxes.

Instructions: In front of you there are 10 ball-point pens and two cardboard boxes. One of them contains the caps belonging to the pens. You are to take one pen in one hand and one cap in the other, put the cap on the pen and then put the pen in the other cardboard box. Perform the task as quickly as possible. Repeat until all the pens have caps and are in the box.

11. Placing cards on a spike

This test measures exactness in directing.

Equipment: A paper spike and 10 cards with a hole in them. The cards are fanned out behind the spike.

Instructions: In front of you there is a paper spike and 10 cards. Your task is to take one card at a time and drop it onto the spike by putting the spike through the hole. Do not lift the spike from the table. Perform the task as quickly as possible and repeat until all cards are on the spike.

12. Twisting a bottle cap

The test measures the ability to perform a different operation with each hand simultaneously: holding and twisting.

Equipment: Ten small plastic bottles with caps, two shallow boxes and a cardboard box. The bottles are placed on the table in one of the boxes and the caps in the other on the side of the dominant hand. The cardboard box is placed on a chair, also on the side of the dominant hand.

Instructions: In front of you there are 10 bottles and 10 caps. I want you to take one bottle and one cap at a time and twist on the cap until it is tight. Then drop the bottle in the box on the chair beside you. Perform the task as quickly as you can and repeat until all the bottles are in the box.

13. Attaching clothes-pins

This test measures the ability of the thumb and the index finger of one hand to squeeze, direct and release an object.

Equipment: Ten clothes-pins and a string tightly stretched. The string is at eye level, the clothes-pins side by side in front of the string on the table.

Instructions: You have 10 clothes-pins in front of you. Your task is to pin them onto the string one by one as fast as you can.

14. Moving thumb-tacks with tweezers

This test measures exactness in picking up an object with one hand using a tool.

Equipment: Twenty thumb-tacks, tweezers, a box. The thumb-tacks are placed on the table in a group with the points upwards beside the box on the side of the dominant hand.

Instructions: You have 20 thumb-tacks in front of you and a box beside them. You are to pick up one thumb-tack at a time using the tweezers in your hand and drop it into the box.

15. Reaction time

The test measures the simple reaction time of the finger to a visual stimulus.

Equipment: A reaction time apparatus with a stimulus lamp and a pushbutton which puts out the light when pressed.

Instructions: In front of you there is a pushbutton to be pressed using your finger. Put your index finger in front of the pushbutton. I want you to press the pushbuttons as quickly as possible when the light comes on.

Evolution des possibilités motrices et du niveau d'intégration
du schéma corporel chez les enfants
normaux et débiles légers

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Ce travail a pour but l'étude du niveau d'habileté motrice et du niveau d'intégration du schéma corporel chez des enfants d'âge d'école primaire normaux et débiles légers.

Des hypothèses de travail ont été posées afin de tenter de répondre à différentes questions telles que:

- dans quelle mesure le retard intellectuel s'accompagne-t-il d'un retard moteur?
- si un retard est mis en évidence, varie-t-il selon la nature de la tâche proposée?
- existe-t-il un parallélisme entre un retard moteur et un retard dans le niveau d'acquisition du schéma corporel?
- existe-t-il des différences dans les niveaux d'acquisition entre les garçons et les filles?

Nous nous sommes plus spécialement intéressés:

1. à évaluer les possibilités motrices au travers de l'habileté manuelle par des épreuves de rapidité et de précision manuelle;
2. à établir le niveau d'intégration du schéma corporel;
3. à établir une comparaison quant à l'âge d'acquisition des possibilités motrices et l'âge d'intégration du schéma corporel;
4. à comparer les enfants normaux et débiles légers quant à leurs possibilités motrices et le niveau d'intégration du schéma corporel;
5. à comparer le niveau d'acquisition des mêmes éléments chez les garçons et chez les filles.

Population

L'étude a porté sur 100 enfants: 60 enfants normaux et 40 enfants débiles légers. Les enfants normaux étaient répartis en trois classes

d'âge: 6 ans, 8 ans, 10 ans. Les enfants débiles légers étaient répartis en deux classes d'âge: 8 et 10 ans. Les écarts tolérés autour de chaque âge ont été limités à trois mois en plus ou en moins.

Les écoles ont été choisies dans un même milieu socio-culturel, de manière à éviter les effets dus aux apprentissages de milieux sociaux différents.

Les quotients intellectuels de la population des débiles légers étaient situés entre 55 et 75 QI. Ils ont été déterminés par la méthode de WISC et Terman-Merrill.

Tests

Les tests de possibilités motrices utilisés sont ceux de Stambak (Zazzo, 1958), décrits dans les épreuves de niveau moteur. Ils comprennent une épreuve de pointillage donnant une idée de la rapidité motrice, une épreuve de découpage mettant en évidence la précision motrice et une épreuve de construction de tours avec et sans pince donnant également une évaluation de la précision motrice.

Ces trois épreuves permettent d'établir une note globale d'habileté manuelle et permet également de déterminer un âge moteur.

Nous avons employé le test de schéma corporel de Daurat-Hmeljak, Stambak et Bergès (1966). Ce test évalue le développement de la connaissance et de la construction mentale du corps. Il s'agit d'une étude des aspects cognitifs du schéma corporel.

Le test comprend trois techniques qui visent chacune un mode différent de représentation du corps: l'évocation, la construction et la reproduction. Les épreuves ont été faites dans la mesure du possible de face et de profil.

Pour chaque population étudiée, nous avons calculé les moyennes ($\bar{X}$) et les écarts types (σ). Les différences entre les populations ont été testées à l'aide du t de Student. Nous avons estimé les différences non significatives (NS) lorsque la probabilité était supérieure à .05 ($p > .05$). Les différences ont été jugées significatives lorsque les probabilités étaient inférieures ou égales à .05.

Les résultats

Age de développement moteur

Enfants normaux (tableau 1). Les garçons de 6 ans montrent un âge de développement moteur significativement inférieur à leur âge chronologique ($p < .001$). A 8 et 10 ans cette différence disparaît. Les filles de 6 et 10 ans ont un âge de développement moteur qui correspond à leur âge chronologique, par contre, à 8 ans elles ont un âge moteur significativement supérieur à leur âge chronologique ($p < .01$).

Enfants débiles légers (tableau 1 bis). Les garçons et les filles à 8 et 10 ans montrent un développement moteur très significativement inférieur à leur âge chronologique ($p < .001$). Les filles normales de 6 et 8 ans sont significativement supérieures aux garçons du même âge (à 6 ans: $p < .02$; à 8 ans: $p < .001$). A 10 ans la différence entre les sexes disparaît. Par contre, les enfants débiles garçons et filles, ne montrent pas de différence significative.

Rapidité manuelle (tableau 2)

Enfants normaux. La rapidité manuelle des filles de 6 et 8 ans est supérieure à celle des garçons. A 10 ans, la différence n'existe plus. Les garçons évoluent favorablement entre 6 et 10 ans, les filles évoluent significativement jusqu'à 8 ans ($p < .001$).

Enfants débiles. La rapidité manuelle n'est pas différente d'un sexe à l'autre et il n'y a pas d'amélioration entre 8 et 10 ans. Les enfants normaux de 8 et 10 ans sont très significativement plus rapides que les enfants débiles de même âge ($p < .01$ et $p < .001$).

Précision manuelle

La construction de tours (tableau 3) avec ou sans pince, ne met en évidence aucune différence entre les sexes, et cela aussi bien chez les enfants normaux que débiles. Les garçons et les filles normaux acquièrent plus de précision manuelle lorsqu'ils avancent en âge. La précision s'améliore dans la construction des tours avec ou sans pince. L'on ne remarque plus de progression significative chez les filles entre 8 et 10 ans (NS).

Seuls les garçons débiles entre 8 et 10 ans montrent une faible progression dans la précision manuelle, et seulement à l'aide d'un instrument.

Lorsque la précision manuelle est évaluée sans instrument, les enfants normaux garçons et filles, sont nettement supérieurs aux enfants débiles de même âge. Par contre, si la précision est évaluée lorsque l'enfant emploie un instrument, il n'y a pas de différence significative entre les enfants normaux et débiles de 8 ans. A 10 ans, la faiblesse des enfants débiles est significativement mise en évidence ($p < .02$).

L'épreuve de découpage (tableau 4) qui mesure également la précision manuelle ne met en évidence aucune différence significative (NS) lorsque l'on compare les sexes entre eux, et cela aussi bien pour les enfants normaux que débiles. Mais, si dans cette épreuve l'on fait intervenir un élément de vitesse, les filles normales de 8 ans sont supérieures aux garçons de même âge. A 6 et 10 ans cette différence n'existe pas. Le temps nécessaire au découpage des cercles d'Ozeretski (Guilmain, 1948) diminue au fur et à mesure que l'enfant grandit. Mais, si les garçons continuent à progresser jusqu'à 10 ans, par contre, à partir de 8 ans, les filles normales et débiles ralentissent leur amélioration. Entre 8 et 10 ans, l'on ne met plus en évidence chez les filles de différences significatives (NS).

Les erreurs, dans l'ensemble, varient très peu. Seulement, chez les enfants normaux, elles diminuent avec l'âge. A 8 ans, il n'y a pas de différence entre enfants normaux et débiles en ce qui concerne la précision de découpage. Mais à 10 ans, les enfants débiles ont besoin d'un temps plus long pour terminer le test.

Schéma corporel

Pour presque toutes les épreuves du schéma corporel, les enfants normaux sont en avance sur les âges tabulaires. Les enfants débiles obtiennent des âges tabulaires soit équivalents à leurs âges chronologiques, soit légèrement en retard ou légèrement en avance.

Nous avons mis en évidence très peu de différence entre sexes. Sur les 21 items que comporte le test, nous n'avons mis en évidence chez les enfants normaux de 8 ans, qu'un seul item pour lequel les

jeunes filles étaient significativement différentes des garçons. Cette différence significative ($p < .02$) en faveur des jeunes filles, a été obtenue lors de la construction du visage de face.

Pour les enfants débiles légers, les différences entre les sexes sont également peu importantes. Elles n'apparaissent aux épreuves de profil que lorsqu'il s'agit de choisir et de placer les pièces. Les différences apparaissent cette fois en faveur des garçons de 8 ans lors de la reproduction du corps de profil ($p < .05$) et lors de la construction du visage de profil ($p < .05$).

Les tableaux 5, 6, 7 et 8 montrent une évolution très importante de la connaissance du schéma corporel des enfants normaux entre 6 et 8 ans. Par contre, entre 8 et 10 ans, les progrès sont peu importants, seuls trois items sur les 21 sont significativement améliorés ($p < .05$).

Les enfants débiles légers montrent entre 8 et 10 ans, les mêmes tendances, quoique les cas où les différences deviennent significatives soient légèrement plus importants (7 items sur 21).

La comparaison entre les enfants normaux de 8 ans et les débiles légers (tableaux 9 et 10) de même âge, montre des différences très significatives en faveur des enfants normaux. Les garçons normaux de 8 ans sont différents des débiles pour 11 items sur 21. Les différences sont encore plus importantes chez les filles, où l'on remarque des différences significatives pour 18 items sur 21. Par contre, à 10 ans, les différences entre enfants normaux et débiles deviennent presque inexistantes. Les garçons ne montrent plus de différences significatives que pour 5 items, les filles pour 6 items sur 21.

Discussions

Les épreuves de possibilités motrices de Stambak employées pour tester des enfants normaux, filles et garçons, de 6 à 10 ans, et des enfants débiles de 8 à 10 ans, ont montré que la débilité mentale des enfants était accompagnée d'une débilité motrice. L'analyse des résultats montre que cette débilité motrice s'accroît entre 8 et 10 ans.

Nous avons montré que la rapidité manuelle est supérieure chez les enfants normaux par rapport aux enfants débiles. Nous ne sommes

sur ce point pas complètement d'accord avec les constatations de Stambak (1968), qui a mis en évidence la relative facilité des débiles mentaux qui réalisaient les épreuves de rapidité. Elle attribuait cette facilité au rôle que joue le développement physique dans le facteur "rapidité".

Stambak (1968) constatait que "les épreuves de précision sont inégalement réussies par les débiles. L'une d'elles (construction de tours) est la mieux réussie de toutes les épreuves appliquées; par contre, le découpage est très mal réussi".

Pour les enfants âgés de 8 ans, nous n'avons pas trouvé de différence significative entre les enfants débiles et normaux lors de la réalisation des tests de construction de tours avec instrument et les tests de découpage. Mais à 10 ans, pour les mêmes tests, les enfants normaux sont supérieurs aux débiles.

De cette constatation l'on peut valablement supposer qu'un apprentissage plus fréquent des enfants débiles aux gestes de précision fine, aurait permis de réduire l'écart entre enfants normaux et débiles de 10 ans.

De l'ensemble des tests de possibilité motrice se dégage la conclusion qu'il y a un décalage entre les âges d'acquisition de l'habileté manuelle des garçons et des filles. Les filles ont un développement plus rapide à 6 et 8 ans, mais ce décalage devient inexistant vers 10 ans.

Les tests du schéma corporel ne mettent pas en évidence de différence entre les sexes, l'on peut donc considérer que la connaissance du schéma du corps suit la même évolution chez les garçons que chez les jeunes filles. L'on peut admettre qu'à l'âge de 8 ans la plus grande partie de l'intégration du schéma corporel a été réalisée, ce qui confirme d'ailleurs nos connaissances à ce sujet (Tournay, 1964; Tournay & Albitreccia, 1959).

La comparaison entre les enfants normaux et débiles légers met en évidence des éléments importants. Ces enfants sont à l'âge de 8 ans très différents au point de vue de l'intégration de l'image corporelle, les enfants débiles montrent un retard certain. Par contre, à 10 ans les différences sont quasi inexistantes, les enfants

débiles ayant rejoints les enfants normaux. L'on voit donc qu'il y a un décalage dans la connaissance du schéma corporel, mais que l'expérimentation a mis en évidence que le retard des enfants débiles était comblé vers l'âge de 10 ans.

Conclusions

Nos expériences nous ont permis de mettre en évidence les faits suivants:

1. la débilité mentale s'accompagne d'une débilité motrice;
2. l'élément le plus important qui affecte la débilité motrice est la rapidité manuelle. Les épreuves de précision ne mettent pas en évidence de grandes différences entre enfants normaux et débiles de 8 ans. Par contre, cette différence s'accroît fortement à 10 ans. Cette constatation permettra d'orienter l'enseignement de manière à solliciter plus intensément la précision motrice fine de telle façon que ces enfants réduisent l'écart qui se creuse par rapport aux enfants normaux;
3. il n'y a pas de parallélisme entre le retard moteur et le niveau d'acquisition du schéma corporel. En effet, la débilité motrice des enfants de 8 ans s'accroît à 10 ans. Par contre, si à 8 ans les débiles légers ont un retard d'acquisition du schéma corporel, ces enfants ont quasiment comblé leur retard à 10 ans. L'on peut donc valablement conclure que le retard moteur des enfants débiles n'est pas dû à un manque d'intégration du schéma corporel;
4. il y a un décalage entre les âges d'acquisition de l'habileté manuelle des garçons et des filles. Les filles ont entre 6 et 8 ans un développement d'habileté manuelle plus rapide que les garçons, mais ce décalage devient inexistant vers 10 ans.

Nos expériences ne nous permettent pas de dire s'il s'agit d'un développement fondamentalement différent, ou si cette différence serait le résultat d'apprentissages culturels variés.

L'étude du niveau d'intégration du schéma corporel ne nous a pas permis de mettre en évidence une différence significative entre les garçons et les jeunes filles.

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ENFANTS NORMAUX

GARCONS

Tableau 1.

AGE CHRONOLOGIQUE	diff t	AGE DEVELOPPEMENT MOTEUR
$\bar{X} = 6$ ans 5,5 mois	S+++	$\bar{X} = 6$ ans 1 mois
$\sigma = 3$ mois		$\sigma = 5,5$ mois
$\bar{X} = 8$ ans 8,5 mois	NS	$\bar{X} = 8$ ans 5 mois
$\sigma = 1,5$ mois		$\sigma = 16,2$ mois
$\bar{X} = 10$ ans 6,5 mois	NS	$\bar{X} = 10$ ans 7 mois
$\sigma = 3$ mois		$\sigma = 1$ an 5 mois

FILLES

AGE CHRONOLOGIQUE	diff t	AGE DEVELOPPEMENT MOTEUR
$\bar{X} = 6$ ans 6 mois	NS	$\bar{X} = 6$ ans 7 mois
$\sigma = 2,5$ mois		$\sigma = 8$ mois
$\bar{X} = 8$ ans 6 mois	S+++	$\bar{X} = 9$ ans 10 mois
$\sigma = 3$ mois		$\sigma = 1$ ans 1 mois
$\bar{X} = 10$ ans 6 mois	NS	$\bar{X} = 10$ ans 10 mois
$\sigma = 3,5$ mois		$\sigma = 1$ ans 2,5 mois

COMPARAISON ENTRE GARCONS ET FILLES

6 ans	S++
8 ans	S++++
10 ans	NS

NS = non significatif (probabilité $> .05$);

S+ = différence significative pour une probabilité $\leq .05$

S++ = différence significative $P \leq .02$

S+++ = différence significative $P \leq .01$

S++++ = différence significative $P \leq .001$

*NOTE: Ces tableaux sont insérés tels que présentés.

ENFANTS DEBILES LEGERS

Tableau 1 bis.

GARCONS

" AGE CHRONOLOGIQUE	' diff t	' AGE DEVELOPPEMENT MOTEUR"
" $\bar{X}$ = 8 ans 6 mois	' S++++	" $\bar{X}$ = 6 ans 6 mois
" σ = 3 mois	'	" σ = 1 an
" $\bar{X}$ = 10 ans 4,5 mois	' S++++	" $\bar{X}$ = 7 ans 7 mois
" σ = 4 mois	'	" σ = 1 an 2 mois

FILLES

" AGE CHRONOLOGIQUE	' diff t	' AGE DEVELOPPEMENT MOTEUR"
" $\bar{X}$ = 8 ans 5 mois	' S+++	" $\bar{X}$ = 6 ans 10 mois
" σ = 4 mois	'	" σ = 1 ans 3,5 mois
" $\bar{X}$ = 10 ans 6 mois	' S++++	" $\bar{X}$ = 7 ans 3 mois
" σ = 3 mois	'	" σ = 1 an 6 mois

COMPARAISON ENTRE GARCONS ET FILLES

8 ans	NS
10 ans	NS

Tableau 2.

AGE	ENFANTS NORMAUX	ENFANTS DEBILES LEGERS
COMPARAISON ENTRE GARCONS ET FILLES		
6 ans	F > G S+	
8 ans	F > G S+	NS
10 ans	NS	NS
COMPARAISON ENTRE GROUPES D'AGE - GARCONS		
6-8 ans	S++++	
8-10 ans	S++	NS
6-10 ans	S++++	
COMPARAISON ENTRE GROUPES D'AGE - FILLES		
6-8 ans	S++++	
8-10 ans	NS	NS
6-10 ans	S++++	
COMPARAISON ENTRE ENFANTS NORMAUX ET DEBILES LEGERS		
GARCONS		
8 ans	N > DL	S+++
10 ans	N > DL	S++++
FILLES		
8 ans	N > DL	S++++
10 ans	N > DL	S++++

PRECISION MANUELLE

(Construction de tours) Tableau 3.
I1 sans instrument
I2 avec pince

AGES	ENFANTS NORMAUX	!	ENFANTS DEBILES LEGERES
COMPARAISON ENTRE GARCONS ET FILLES			
	I1	I2	I1 I2
6 ans	NS	NS	NS NS
8 ans	NS	NS	NS NS
10 ans	NS	NS	NS NS
COMPARAISON ENTRE GROUPES D'AGE - FILLES			
	I1	I2	I1 I2
6-8 ans	S+	S+++	NS NS
8-10 ans	NS	NS	NS NS
6-10 ans	S++++	S++++	NS NS
COMPARAISON ENTRE GROUPES D'AGE - GARCONS			
	I1	I2	I1 I2
6-8 ans	S++	S++	NS S+
8-10 ans	S+++	S+++	NS S+
6-10 ans	S++++	S++++	NS S+
COMPARAISON ENTRE ENFANTS NORMAUX ET DEBILES LEGERES			
GARCONS			
	I1	I2	I1 I2
8 ans	N > D S+	NS	S++ N > D
10 ans	N > D S+	NS	S++ N > D
FILLES			
	I1	I2	I1 I2
8 ans	N > D S++	NS	S+++ N > D
10 ans	N > D S+++	NS	S+++ N > D

TEST DU SCHEMA CORPOREL

de C. Daurat-Hmeljak, M. Stambak, J. Bergès

Tableau 5.

COMPARAISON ENTRE DIFFERENTS GROUPES D'AGE

1. Reconnaissance des pièces

AGES	ENFANTS NORMAUX			ENFANTS DEBILES		
	Corps face	Visage face	Visage profil	Corps face	Visage face	Visage profil
<u>garçons</u>						
6-8 ans	NS	S++	S+++			
8-10 ans	NS	NS	NS	S+	NS	NS
6-10 ans	NS	S+++	S+			
<u>filles</u>						
6-8 ans	S+	S++	NS			
8-10 ans	NS	NS	NS	NS	S+	S+
6-10 ans	S+++	S+++	S+			

PPECISION MANUELLE

Tableau 4.

Découpage

E= essai sans consigne de vitesse

EV= avec consigne de vitesse

AGES	ENFANTS NORMAUX				ENFANTS DEBILES LEGERS			
COMPARAISON ENTRE GARCONS ET FILLES								
	E		EV		E		EV	
	Temps	Erreurs	Temps	Erreurs	Temps	Erreurs	Temps	Erreurs
6 ans	NS	NS	NS	NS				
8 ans	NS	NS	S+ F>G	NS	NS	NS	NS	NS
10 ans	NS	NS	NS	NS	NS	NS	NS	NS
COMPARAISON ENTRE GROUPES D'AGE - GARCONS								
6-8 ans	S++++	S+	S+	NS				
8-10 ans	S+++	NS	S++++	NS	S++	NS	S+	NS
6-10 ans	S++++	S++	S++++	NS				
COMPARAISON ENTRE GROUPES D'AGE - FILLES								
6-8 ans	S++	NS	S++	S+++				
8-10 ans	NS	NS	NS	NS	NS	NS	NS	NS
6-10 ans	S++++	NS	S++++	S++				
COMPARAISON ENTRE ENFANTS NORMAUX ET DEBILES LEGERS								
	E				EV			
	Garçons		Filles		Garçons		Filles	
	Temps	Erreurs	Temps	Erreurs	Temps	Erreurs	Temps	Erreurs
8 ans	NS	NS	NS	NS	NS	S+	NS	S+++
10 ans	S+++	NS	S+	S+++	S+	NS	NS	S+++

TEST DU SCHEMA CORPOREL

Tableau 6.

COMPARAISON ENTRE DIFFERENTS GROUPES D'AGE

2. Pièces bien placées

AGES	ENFANTS NORMAUX			!	ENFANTS DEBILES		
CORPS DE FACE							
	Evocation	Construction	Reproduction	!	Evocation	Construction	Reproduction
Garçons							
6-8 ans	S++	S+	S+++	!	NS	S++	NS
8-10 ans	NS	NS	NS	!			
6-10 ans	S+++	S+++	S+++	!			
Filles							
6-8 ans	NS	S+++	S+++	!	NS	S+	NS
8-10 ans	NS	NS	NS	!			
6-10 ans	S+++	S++	S++	!			
VISAGE DE FACE							
Garçons							
6-8 ans	S+++	NS	S+	!	NS	NS	NS
8-10 ans	NS	S++	NS	!			
6-10 ans	S++++	S+++	S+	!			
Filles							
6-8 ans	S++++	S++++	S++	!	NS	NS	NS
8-10 ans	NS	NS	NS	!			
6-10 ans	S++++	S++++	S+	!			

TEST DU SCHEMA CORPOREL

Tableau 7.

COMPARAISON ENTRE DIFFERENTS GROUPES D'AGE

3. Pièces bien choisies

AGES	ENFANTS NORMAUX			!	ENFANTS DEBILES		
CORPS PROFIL							
	Evocation	Construction	Reproduction	!	Evocation	Construction	Reproduction
Garçons				!			
6-8 ans	S+++	S+++	S+	!	NS	NS	NS
8-10 ans	S+	NS	NS	!			
6-10 ans	S+++	S+++	S+	!			
Filles				!			
6-8 ans	S+++	S++	NS	!	NS	NS	NS
8-10 ans	NS	S+	NS	!			
6-10 ans	S+++	S+++	NS	!			
VISAGE PROFIL							
Garçons				!			
6-8 ans	S+++	S+++	S+++	!	NS	NS	NS
8-10 ans	NS	NS	NS	!			
6-10 ans	S+++	S+++	S+++	!			
Filles				!			
6-8 ans	S+++	S+++	S+++	!	S+++	NS	NS
8-10 ans	NS	NS	NS	!			
6-10 ans	S+	S+++	S+++	!			

TEST DU SCHEMA CORPOREL

Tableau 8.

COMPARAISON ENTRE DIFFERENTS GROUPE D'AGE

4. Pièces bien choisies et bien placées

AGES	ENFANTS NORMAUX			!	ENFANTS DEBILES		
CORPS PROFIL							
	Evocation	Construction	Reproduction	!	Evocation	Construction	Reproduction
<u>Garçons</u>							
6-8 ans	S+	S+++	S+++	!	NS	NS	NS
8-10 ans	NS	NS	NS	!			
6-10 ans	S+++	S++++	S+++	!			
<u>Filles</u>							
6-8 ans	S++	S+++	S++	!	NS	NS	NS
8-10 ans	NS	NS	NS	!			
6-10 ans	S+++	S++++	S++	!			
VISAGE PROFIL							
<u>Garçons</u>							
6-8 ans	NS	S+++	S++++	!	NS	NS	NS
8-10 ans	NS	NS	NS	!			
6-10 ans	S++++	S+++	S++++	!			
<u>Filles</u>							
6-8 ans	S++++	S+++	S++++	!	S+	NS	S+
8-10 ans	NS	NS	NS	!			
6-10 ans	S+++	S+++	S++++	!			

TEST DU SCHEMA CORPOREL

de C. Daurat-Ilmeljak, M. Stambak, J. Bergès

COMPARAISONS ENTRE ENFANTS NORMAUX ET DEBILES

Tableau 9.

1. Reconnaissance des pièces				
	Ages	Corps face	Visage face	Visage profil
garçons	8 ans	S+	S+	S+++
	10 ans	NS	NS	NS
filles	8 ans	NS	S+++	S++
	10 ans	NS	NS	NS
2. Pièces bien placées				
Corps face				
		Evocation	Construction	Reproduction
garçons	8 ans	NS	S++++	NS
	10 ans	NS	NS	NS
filles	8 ans	S+++	S+++	S++
	10 ans	S+++	NS	NS
Visage face				
garçons	8 ans	NS	S+	NS
	10 ans	NS	S+	NS
filles	8 ans	S++	S+++	NS
	10 ans	NS	S+	NS

TEST DU SCHEMA CORPOREL

Tableau 10.

COMPARAISONS ENTRE ENFANTS NORMAUX ET DEBILES

3. Pièces bien choisies					
Corps profil					
	Ages	Evocation	Construction	Reproduction	
Garçons	8 ans	NS	NS	NS	
	10 ans	S+++	NS	NS	
Filles	8 ans	S+	NS	S+	
	10 ans	S++	S+++	NS	
Visage profil					
Garçons	8 ans	S++	S+	S++	
	10 ans	NS	S++	S+	
Filles	8 ans	S+++	S+	S+++	
	10 ans	NS	NS	NS	
4. Pièces bien choisies et bien placées					
Corps profil					
Garçons	8 ans	S+	NS	NS	
	10 ans	S++	NS	NS	
Filles	8 ans	S+++	S+++	S++	
	10 ans	S+	S++	NS	
Visage profil					
Garçons	8 ans	NS	S+++	S+++	
	10 ans	S+	NS	NS	
Filles	8 ans	S++++	S+++	S++++	
	10 ans	NS	NS	NS	

De l'inflow à l'outflow lors de la reproduction
d'un mouvement d'adduction horizontale du bras - II:
enfants sourds*

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Énoncé du problème

Les résultats qui seront rapportés ici donnent suite à ceux déjà publiés dans deux articles antérieurs (Nadeau & Simard, 1975; Nadeau, Simard & Pitre, 1976). L'expérience que nous allons décrire constituait la dernière d'une série destinée à élucider, au moyen d'une tâche classique de reproduction de mouvement, certaines facettes du système kinesthésique chez l'humain. Nous nous limiterons donc à rappeler l'essentiel du rationnel sous-jacent à cette série de quatre expériences. Ainsi, nous renvoyons le lecteur aux deux articles mentionnés précédemment.

Le système kinesthésique représente pour nous un des systèmes dont dispose l'opérateur humain pour fournir un rendement optimal. Nous prétendons qu'il s'agit d'un système à base cognitive et à dominante outflow responsable de la planification, de la rétention, de

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l'initiation et de la supervision du mouvement corporel. Un des postulats de base de notre modèle de ce système stipule que ce dernier opère selon une dominante outflow. Plus précisément, cela signifie que le guidage central de l'efférence (GCE) est la condition nécessaire et suffisante pour un rendement optimal de ce système. Nous voyons le guidage central de l'efférence sous la forme d'une voie unidirectionnelle reliant des mécanismes idéo-moteurs (comportement imagé) aux déplacements segmentaires (comportement manifeste). Une telle position théorique met en doute la pertinence de la rétroaction périphérique (inflow) de type proprioceptif dans le contrôle du mouvement volontaire chez l'humain. Jusqu'à un certain point, notre position théorique se situe dans la ligne des récentes discussions présentées par Jones (1974a, 1974b).

La séquence mouvement-critère + reproduction nous est apparue une technique valide pour amorcer une vérification du postulat outflow au niveau comportemental. Pour le moment, il s'agissait d'obtenir un patron de la performance du système kinesthésique à travers les conditions de mouvement suivantes: stimulation passive + reproduction passive (SP-RP), stimulation passive + reproduction active (SP-RA), stimulation active avec butée + reproduction active (SA_B -RA), autostimulation + reproduction active (A-RA).

Plusieurs travaux récents (Nadeau, Simard & Pitre, 1976) nous enseignent que les conditions de mouvement influencent la performance du système kinesthésique de telle sorte qu'il devient possible d'obtenir de l'information sur son fonctionnement à travers les caractéristiques des conditions qui entraînent le meilleur rendement. Dans cette perspective, nous désirions savoir si le système kinesthésique se comporterait de manière similaire chez quatre petits échantillons de sujets à prime abord différents: des adultes voyants (A_V), des enfants voyants (E_V), des enfants demi-voyants (E_{DV}), des enfants sourds (E_S), ceci à travers les quatre conditions de mouvement mentionnées auparavant. Nous nous attendions à retrouver un patron commun caractérisé par une amélioration de la performance de la condition SP-RP à la condition A-RA. Nous rapportons ici les résultats obtenus chez les enfants sourds à la suite de la quatrième expérience.

Méthode

Appareillage

Comme instrument principal, nous avons utilisé la Version 2 du kinesthésiomètre de Nadeau et Delage ou KINADEL (voir Nadeau & Simard, 1976, pour une description détaillée). Compte tenu du type d'usage que nous faisons de cette Version 2, on peut considérer l'appareillage comme similaire à la Version 1 utilisée à l'intérieur des trois expériences précédentes. La seule différence réelle par rapport à la présente expérience consistait en l'absence de l'arc de cercle supportant l'extrémité distale du levier. En effet, sur cette nouvelle version à deux leviers, l'extrémité distale de chaque levier se trouve complètement suspendue, ce qui contribue à réduire la friction. La Version 2 fut utilisée puisque nous pouvons maintenant transporter cet appareil sur les lieux de l'expérimentation. Nous faisons justement face à cette situation car nous devons nous rendre à l'Institut des Sourds si nous voulions obtenir les sujets. Pour ce qui est des autres informations relatives à l'appareillage, le lecteur peut se reporter à un article paru récemment (Nadeau, Simard & Pitre, 1976).

Plan de l'expérience

Tout comme pour les expériences précédentes, nous avons fait appel à un plan factoriel avec blocs aléatoires (Kirk, 1968), effets fixes et mesures répétées sur tous les facteurs. Chaque sujet constituait un bloc.

Deux variables indépendantes furent manipulées: les conditions de mouvement à trois niveaux (SP-RA, SA_B-RA, A-RA); les positions de départ de la reproduction à trois niveaux (5⁰ derrière le départ du mouvement-critère, 2⁰ devant le départ du mouvement-critère, 5⁰ devant le départ du mouvement-critère). Contrairement aux expériences précédentes, nous ne considérons pas les séances de testing comme un facteur lors des analyses de la variance. De plus, il fut impossible de manipuler la condition SP-RP étant donné que les enfants n'arrivèrent pas à comprendre la procédure de cette condition. Il n'en demeure pas moins que notre interprète déploya toute son habileté pour tenter d'en arriver à une compréhension satisfaisante.

Pour ce qui est des variables dépendantes, nous avons fait appel à l'erreur constante (ou algébrique) ainsi qu'à l'erreur variable. Pour nous, l'erreur constante nous informe sur la précision du système kinesthésique tandis que l'erreur variable nous renseigne sur la fiabilité de ce système. De manière à faciliter la comparaison de nos résultats avec ceux de d'autres expériences, nous rapportons ici la performance en regard de l'erreur absolue.

Au plan des techniques statistiques, nous suivions la démarche appropriée à notre plan d'expérience (Kirk, 1968; Lana & Lubin, 1963), à savoir: (a) test de non-additivité de Tukey pour savoir s'il y avait une interaction blocs x traitements; (b) analyse de la variance avec le calcul des F conventionnels et conservateurs; (c) T^2 de Hotelling dans le cas d'une discordance entre le F conventionnel et le F conservateur.

Procédure

Mise à part l'absence de la condition SP-RP, la procédure de l'expérience était en tout point identique à celle des trois expériences précédentes (Nadeau, Simard & Pitre, 1976). L'absence de la condition SP-RP entraînait une diminution du nombre d'essais par séance, le portant à 54 au lieu de 72.

Sujets

Il s'agissait de six enfants sourds depuis la naissance, âgés de 11 à 13 ans, et résidant dans une institution spécialisée. De l'avis du psychologue attaché à l'institution, ils étaient comparables sur le plan intellectuel (c'est-à-dire dans la moyenne supérieure) aux enfants voyants et demi-voyants qui participèrent aux expériences 2 et 3. Tous étaient droitiers manuels, volontaires et ne recevaient aucune rémunération. Ils furent testés à l'intérieur de leur institution. Nous déterminions la prévalence manuelle au moyen des épreuves décrites par Nadeau (1972).

Résultats

Expériences 1, 2, 3

Le lecteur est prié de se reporter à l'article de Nadeau, Simard & Pitre (1976), mais il pourra trouver l'essentiel de ces résultats sur les tableaux présentés à l'intérieur de la présente section.

Expérience 4

Chez les enfants sourds (E_S), le test de Tukey ne faisait pas apparaître d'interaction blocs x traitements tant au niveau de l'erreur constante ($F(1,39) = .788, p > .25$) que de l'erreur variable ($F(1,39) = 1.06, p > .25$) et de l'erreur absolue ($F(1,39) = .806, p > .25$). Ainsi, il est permis de croire que les traitements agissaient dans la même direction au sein de chaque bloc.

L'analyse de la variance appliquée à l'erreur constante (tableaux 1 et 3) dégagait un effet principal du facteur conditions de mouvement ($F(1,5) = 8.640, p < .05; T^2 = 132.478, p < .01$). Un test de Duncan ($p < .01$) montrait que la condition A-RA entraînait une performance significativement supérieure à celles obtenues dans les deux autres conditions, les performances à l'intérieur de ces dernières s'avérant similaires (Tableau 1). Il n'y avait pas d'effet principal significatif au sein du facteur positions de départ de la reproduction (Tableau 3). Aucune interaction significative ne ressortait de cette analyse.

L'analyse de la variance appliquée à l'erreur variable (Tableaux 2 et 4) ne dégagait ni effet principal, ni interaction au sein des deux facteurs manipulés.

L'analyse de la variance appliquée à l'erreur absolue (Tableaux 5 et 6) dégagait un effet principal du facteur conditions de mouvement ($F(1,5) = 6.268, p < .05; T^2 = 87.247, p < .01$). Un test de Duncan ($p < .01$) montrait que la condition A-RA entraînait une performance significativement supérieure à celles obtenues dans les deux autres conditions, les performances à l'intérieur de ces dernières s'avérant similaires (Tableau 5). Il n'y avait pas d'effet principal significatif au sein du facteur positions de départ de la reproduction (Tableau 6). Aucune interaction significative ne ressortait de cette analyse.

Tableau 1

Erreurs constantes (degrés) obtenues selon les
conditions de mouvement

Groupe	Conditions de mouvement			
	SP-RP	SP-RA	SA _B -RA	A-RA
A _V	-27.821	1.799	1.334	.261
E _V	-31.566	12.641	12.489	1.889
E _{DV}	-22.552	15.103	14.793	1.589
E _S	*	11.970	12.041	-.324

*Condition non-manipulée

Tableau 2

Erreurs variables (degrés) obtenues selon les
conditions de mouvement

Groupe	Conditions de mouvement			
	SP-RP	SP-RA	SA _B -RA	A-RA
A _V	10.401	2.814	2.959	2.587
E _V	11.618	3.893	3.981	4.338
E _{DV}	13.903	5.466	5.449	5.902
E _S	*	9.618	9.695	7.076

*Condition non-manipulée

Tableau 3

Erreurs constantes (degrés) obtenues selon les positions
de départ de la reproduction

Groupe	Départ de la reproduction		
	-5°	+2°	+5°
A _V	-5.750	-4.444	-3.125
E _V	-3.097	-1.007	0.703
E _{DV}	-0.066	2.858	3.907
E _S	5.722	8.612	9.353

Tableau 4

Erreurs variables (degrés) obtenues selon les positions
de départ de la reproduction

Groupe	Départ de la reproduction		
	-5°	+2°	+5°
A _V	5.240	4.658	4.173
E _V	6.635	5.515	5.722
E _{DV}	7.569	7.911	7.561
E _S	9.098	9.080	8.211

Tableau 5

Erreurs absolues (degrés) obtenues selon les
conditions de mouvement

Groupe	Conditions de mouvement			
	SP-RP	SP-RA	SA _B -RA	A-RA
A _V	23.089	3.600	3.737	2.477
E _V	31.897	12.796	12.627	4.131
E _{DV}	23.094	14.828	14.305	5.605
E _S	*	14.939	14.892	5.981

*Condition non-manipulée

Tableau 6

Erreurs absolues (degrés) obtenues selon les positions
de départ de la reproduction

Groupe	Départ de la reproduction		
	-5°	+2°	+5°
A _V	8.490	8.087	8.100
E _V	15.267	15.703	14.628
E _{DV}	15.898	16.395	15.238
E _S	11.767	12.708	13.987

Discussion

Les résultats rapportés indiquent que le système kinesthésique accusait chez les enfants sourds un comportement similaire à celui retrouvé chez les autres petits échantillons (Nadeau, Simard & Pitre, 1976). Pour cette raison, nous renvoyons le lecteur à la discussion présentée à la fin de l'article qui vient d'être mentionné.

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Some beneficial effects from participation
in an individualized exercise prescription
cardiac rehabilitation program

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Cardiac rehabilitation programs that serve patients who have suffered infarcts are prevalent throughout North America. As far as can be determined to date the cardiac rehabilitation program at the University of Ottawa is the only one extant that devotes its services solely to patients who have undergone Coronary Artery By-Pass Graft operations. The operations were performed at the Ottawa Civic Hospital's reknowned Cardiac Unit. Every patient in the program has had open heart surgery.

Due to the nature of the illness - occluded arteries - one consequence that occurs is serious deconditioning in the individuals suffering from this malady. Insufficient blood flow reduces the level of nutrients and oxygen available to the muscles (Devries, 1974) causing the level of activity to decrease which, in turn, results in a lower fitness level. A lower fitness level, combined with occluded arteries, leads to still lesser activity, causing a self-perpetuating downward cycle that is remedied, in part, by surgery, which allows for an increase in blood circulation.

This type of heart ailment is very debilitating for the individual. Viewed from the vantage point of the cardio-thoracic surgeon the challenge is immense. Not only is the illness serious and the operation a very delicate one, but the patient, in a deconditioned state, is about to face a major trauma to his system in the form of surgery. For the physiotherapist and physical educator there is the knowledge that these people are starting from a very low level of fitness and any rehabilitation program must provide individual care and close supervision (Powell, 1972). Despite the seriousness of the surgical

procedure a mild form of rehabilitation is started in the hospital as soon as possible following surgery.

Through a gradual process of mild rehabilitation and healing progress is made. After a minimum of three months a selected number of patients are recommended by their physicians to our program. This illustrates one level of cooperation, involving the Ottawa Civic Hospital, a number of private physicians, and the University of Ottawa through the Faculty of Medicine and the School of Human Kinetics and Leisure Studies. A second example of cooperation is seen in the program itself where the services of a physiotherapist attached to the hospital, an exercise physiologist from the Department of Kinanthropology, a physical educator from the Department of Physical Education, and a private physician are all combined to implement and conduct the program.

While the positive role of exercise in certain types of cardiovascular disease is established (American College of Sports Medicine, 1975) there does not appear to be any literature published - either theoretical or applied - regarding the role of exercise in the rehabilitation of patients who have had open heart surgery. In general it can be stated that properly prescribed physical activity is beneficial since it maintains or increases functional capacity (American College of Sports Medicine, 1975); it is assumed that this basic concept also applies to people who have had open heart surgery.

When a patient is deemed ready for the program he is recommended by his physician, who can be either the cardio-thoracic surgeon, the cardiologist, or the family physician. The first step in the program is an exercise stress test that includes a 12-lead electrocardiogram. Administration of the test is done by the exercise physiologist; medical supervision is provided by the physician attached to the program. Using a treadmill, a sub-maximal test is employed and the results obtained are used to project maximum work capacity in terms of maximum heart rate. From this data 60%, 70% and 80% work capacity is determined in terms of heart rate. Heart rate is then converted into work intensity by a formula (Jetté, Thoden, & Gauthier, 1975) that indicates the desired walking or jogging pace to obtain a 60% work level.

This data is transmitted to the physical educator and provides the base for the initial prescription. Identification of the 60% work level in terms of heart rate is important because that is the level that must be surpassed during the endurance phases of the program to ensure that the participant has obtained a training effect.

The initial exercise prescription can be safely determined from the knowledge generated by the stress tests (American College of Sports Medicine, 1975); this data is used as the guideline in writing the exercise prescription for the first training session. Not only does the data from the stress tests reflect the working capacity of each individual but it also provides a guideline for the intensity of the activity to be prescribed.

Proper principles are used in the selection and design of the exercise program (DiGennaro, 1974; Kasch & Boyer, 1968; Vitale, 1973) which consists of five phases: (a) warm-up; (b) calisthenics; (c) endurance; (d) calisthenics, and (e) endurance. A cooling down phase is included at the end. During the calisthenics phases the exercises are done at four stations which are located at different places in the gym. A list and description of each exercise to be performed at that station is posted.

Inclusion of two phases devoted to cardiovascular endurance follows the recommendation made by the American Medical Association's Committee on Exercise that emphasis be placed on aerobic type exercises (The Committee on Exercise, 1972). Heart rate is used as the monitor (Vitale, 1973).

Three additional principles - individualization, overload, and safety - are integral to the program. Information pertaining to these principles along with the details of the program is conveyed to each person at the first session.

Individualization is stressed and implemented through the provision of an individualized exercise prescription for every person for each training session. Each new exercise prescription is based on the adaptation of that particular individual to the preceding prescription. Observation, verbal feedback, and monitored heart rate provide input which is considered in determining the next prescription.

Each person, with his own exercise prescription form in hand, works at his own pace, completing the five phases by doing the specific activities prescribed for him. Working individually in this manner means that no competition exists in the program. Benefits accrue because the prescription accounts for the kinds of activities, intensity, and duration (American College of Sports Medicine, 1975) best suited to each individual.

Overload principle (Kasch & Boyer, 1968), the basic training principle applicable to all training programs, is implemented in very small increments, in the following ways:

Calisthenics. Start with simple exercises and a low number of repetitions; first the number of repetitions is increased and when 24 repetitions is reached these exercises are replaced by more difficult variations with the number of repetitions sharply reduced.

Endurance. Start with the distance and rate indicated by the results of the stress tests; first the distance walked is increased with the rate remaining constant; next comes an increase in the speed of walking, and then at the appropriate time jogging is introduced. Initial jogging covers a short distance at a slow pace; gradually distance is increased and then comes an increase in pace.

Safety is accounted for in the attitude taken. A conservative approach is used in determining the initial exercise load; the same approach persists in the implementation of the overload principle by prescribing comfortable increments. It may take somewhat longer for each person to attain optimal fitness but the risks are minimized.

At the start of each training session each participant's pre-exercise heart rate is monitored and recorded along with his weight. Under the supervision of the attending physician, the physiotherapist, and the physical educator each person follows his own prescription, doing the activities prescribed for him in that training session. Heart rate is recorded immediately following each endurance phase.

Sparked by the advent of Cooper's book (Cooper, 1968), the current trend of thought stresses cardiovascular improvement as the most important fitness component to be developed in adults. The American Medical Association's Committee on Exercise is in agreement with this

view (The Committee on Exercise, 1972). This very same thinking pervades our program.

Patients who have had open heart surgery should not be tested to exhaustion to determine maximum performance. Such testing is contraindicated and superfluous since the results of the sub-maximal tests can be converted safely into the initial exercise prescription. This initial prescription reflects each person's appropriate pre-program level of work capacity. Regarding calisthenics, which are geared to improving flexibility, muscular endurance, and to a small degree, strength, a comparison between the exercises and repetitions found in the first prescription and those found in the last session before graduation, shows major gains. However, since the major concern in the program is improved cardiovascular function it is in the endurance phase of the program that the beneficial effects from participation in the program can be found. The benefits, detailed in human performance terms, as illustrated by the following five case studies, are shown in table form (Table 1).

Subject A entered the program in reasonably good condition. In his last training session with us he jogged, non-stop, for close to 12 minutes, covering approximately 1.2 miles. Following his second set of calisthenics he then jogged .66 mile in seven minutes. How many Canadian men, age 62, can match that performance?

Subject B, a younger man of 43, improved quickly and steadily from the start. In his last session with us he jogged one mile in 10 min 30 sec in the first endurance phase and then in his second endurance phase he was very close to jogging another mile. His performance places him well above the average for adult males his age.

We have had very few females in the program; subject C was one. She responded well to the exercise program and in her last session with us she was able to jog, non-stop, for over seven minutes, covering .5 mile.

Subject D is a tall, husky gentleman who obviously was very powerful in his youth. He enjoyed the calisthenics and responded well to the increased intensity while walking. When he started jogging - two laps around the gym was the initial prescription - he completed the

Table 1

First prescription for both endurance phases compared to last prescription for both endurance phases

Subject	Sex	Age	First prescription endurance phases		Last prescription endurance phases	
A	M	62	Walk - 1 Walk - .8	mile - 15:00 mins mile - 13:20 mins	Jog - 1.2 miles - 11:40 mins Jog - .66 mile - 7:00 mins	
B	M	43	Walk - .66 Walk - .50	mile - 11:00 mins mile - 9:10 mins	Jog - 1 mile - 10:30 mins Jog - .9 mile - 9:30 mins	
C	F	38	Walk - .66 Walk - .5	mile - 14:15 mins mile - 11:30 mins	Jog - .5 mile - 7:15 mins Walk- 1.1 miles - 18:40 mins	
D	M	58	Walk - .66 Walk - .66	mile - 11:00 mins mile - 12:00 mins	Jog - 1 mile - 10:30 mins Jog - .6 mile - 6:25 mins	
E	M	41	Walk - 1 Walk - .66	mile - 18:00 mins mile - 12:24 mins	Jog - 1.33 miles - 15:08 mins Jog - 1.22 miles - 11:36 mins.	

(Each person follows the five phases of the program - warm-up, calisthenics, endurance, calisthenics, and endurance - in all the training sessions. When examining the comparison of results as shown in Table 1 it must be remembered that the warm-up phase and the two calisthenics phases were also performed in every training session).

two laps and promptly announced the initial prescription, two laps, was definitely his outside limit. He was convinced that he could not jog any further. About eight months later he completed one mile (18 laps) in the first endurance phase and then after his second set of calisthenics he then jogged .6 mile.

Subject E responded well to the exercise program and his achievements serve as an inspiration to everyone connected with the program. His performance in the last training session, jogging 1.33 miles and then an additional 1.22 miles signifies the attainment of a fitness level that would rank him at, or very near, the top when compared to the total population in his age group.

The data can be examined from two different perspectives. In the first, a comparison is made between the initial prescription and the work done in the final training session. It is clear that each person benefitted from the program, indicating that exercise has a positive role to play in the rehabilitation of patients who have had Coronary Artery By-Pass Graft surgery. The ability to walk or jog over an extended period of time reflects an improvement in cardiovascular function - a significant benefit.

A second examination of the data can be made by comparing the performances recorded in the last training session by these people, former invalids, to their own peers in the general population. Each person in the program has attained a high level of fitness, indicating an ability to outperform most of the "normal" people in their age group.

The beneficial effects that accompany a high level of physical fitness are well known. Whether comparing initial performance to final performance, or final performance to the general population, it is clear that the people in the program have attained a high level of physical fitness and therefore, it follows, benefit from the effects that ensue from that state.

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Expansion of extra cellular space and control of body temperature at intermediate altitude*

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Introduction

Altitude environments challenge the volume and the composition of extracellular space in mammals (Stowe & Ruiz, 1966; Stowe & Ruiz, 1968). In response to this challenge the body has to set up several mechanisms for keeping the homeostasis (Durand, Raynaud, Martineau, Varene & Couder, 1963). Among these mechanisms, the ones dealing with distribution of internal heat by the extracellular fluid are important in physiology.

Physical exercise increases metabolic rate in muscle cells. This results in a several fold increase in heat production by muscle (Passmore & Durin, 1955). The excess of heat must be eliminated as fast as possible from the body to avoid a dangerous overheating of the tissues that can disturb normal cellular activity. The interstitial fluid and the circulatory system play a very important role in removing the excess heat from the muscles and carrying it to the skin and the membranes lining the respiratory tract, (Edholm, Fox & MacPherson, 1956) where mechanisms of convection and evaporation of water are important for the removal of heat from the body (Massey & Coburn, 1972). This report relates mainly to the mechanisms of evaporation and "dilution of heat" that maintain a low body temperature during heavy work.

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Materials and method

The capacity of humans to eliminate heat from the body during work performed at intermediate altitudes was studied in Bogotá at an elevation of 8,390 feet (2,600 m). The data for this study was collected from 127 observations obtained from non-athlete male and female students aged 18 to 25 years at the Department of Physical Education of Universidad Pedagógica. The work designed to measure the rate of evaporation from the surface of the body was gymnastics performed on a bike or a run during a 30 minute period (Peralta, 1975). Series of exercises were done before and after expanding extracellular fluid (ECF) (Ruiz, 1973) by a salt load of 12,000 mEq of sodium given daily in chicken or meat broth, in addition to the regular meals of all students participating in the experiment. Differences in the internal (rectal) and external (sublingual) temperatures as well as decreases in body weight induced by water loss during exercises were carefully monitored in all experiments. In these experiments other heat losses from the body carried out by radiation, conduction or convection were minimized by means of special cotton sweat suits provided the participants; these losses were not taken into consideration for calculations. On the other hand, all exercises were performed under constant environment, using the facilities of indoor gymnasium. The temperature of the air was 65.0° F dry bulb (18.3° C), and the relative humidity 60%.

Calculations were made by means of the analysis S.P.S. version G and the breakdown crossed up programs using a 360 IBM computer.

The amount of heat lost by exercise is expressed in kilocalories per hour (Kcal/hour). This amount is proportional to the evaporative heat loss H_e and can be written:

$$H_e = 0.58 (R_{H_2O})$$

where R_{H_2O} is the rate of water evaporated from the surface, and the constant 0.58, the kilocalories used to vaporize one gram of water (Edholm *et al*, 1956; Ruch, 1973). The figure for the rate of water evaporated is obtained from the difference in body weight before and after exercises.

Results

The capacity of the environment to remove water vapor from the surface of the body depends on the relative humidity of the air (Ruch, 1973). If the ambient air is dry, the evaporation rate is high. On the other hand, if the relative humidity is high, the ability of the ambient air to remove water vapor is reduced. Figure 1 shows the relationship between the relative humidity of the air and the evaporation rate of the body in Bogotá. The largest evaporation rate occurred only when the humidity of the air averaged 60%.

Sodium load expanded the ECF as shown by increases in total body weight that averaged 0.5 to 1.0 kilograms in all individuals taking salt. The sodium load also reduced the evaporation rate, as shown by the smaller degree in weight losses obtained after exercises. This effect was notorious in males but negligible in females (Figure 2).

It appears that the expansion of ECF improved the capacity of the body to maintain lower internal temperatures after performing heavy physical work, as demonstrated by the lower temperatures recorded under the influence of the sodium load. Figure 3 depicts the increases in rectal temperatures after 30 minutes of intensive exercise before and after the salt load.

Table 1 compares the heat loss expressed in kilocalories and the increase in rectal temperature. It can be seen that the females eliminated a larger amount of heat than males, and that the increases of internal temperature in females were lower than the increases observed in males.

Discussion

Water has an elevated caloric capacity which enables it to store a large amount of heat without increasing its temperature very much. The animal body uses this property to keep within the narrow limits compatible with life, the internal temperature thus insuring normal cellular functions (Massey & Coburn, 1972).

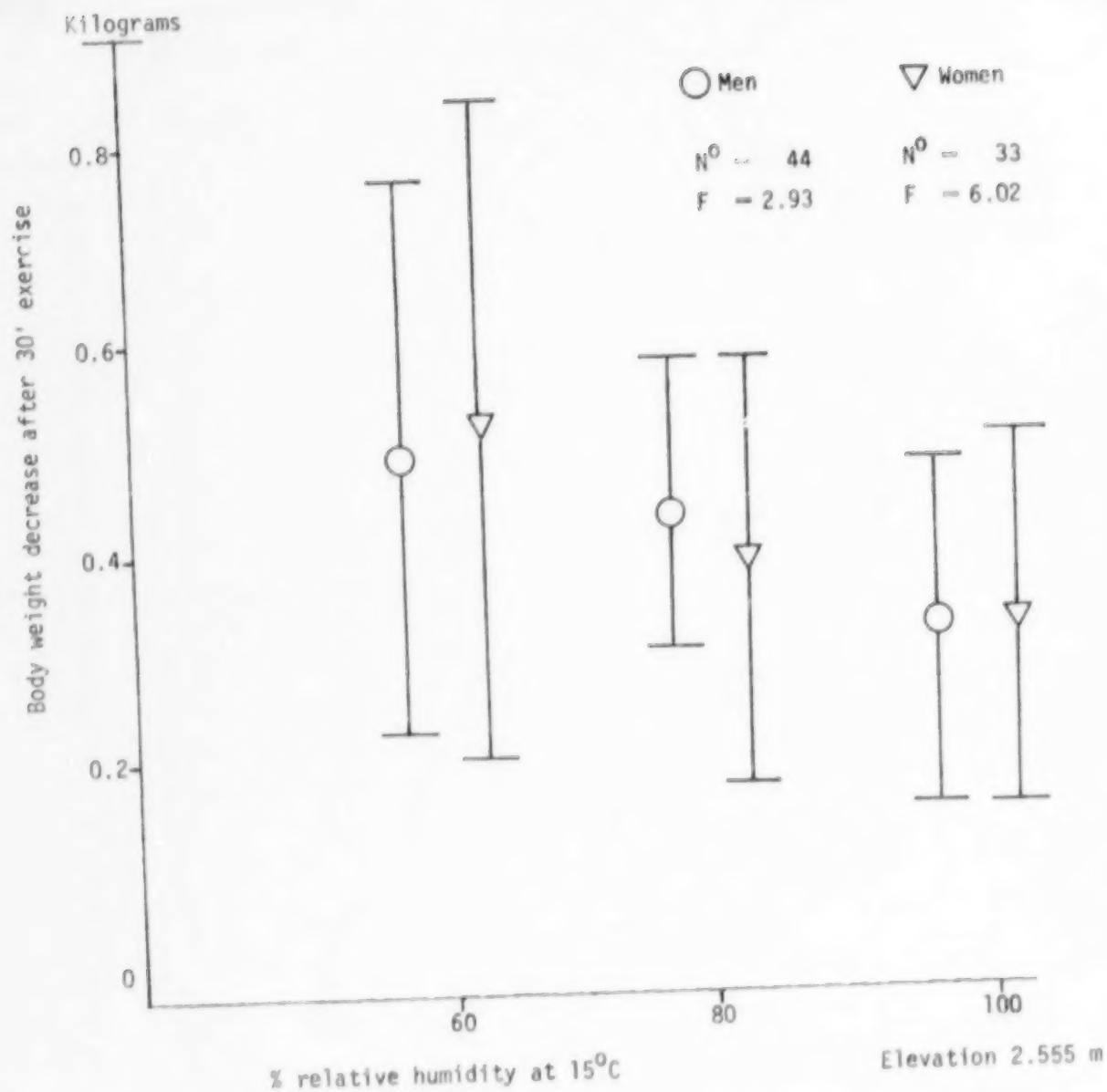


Figure 1. The volume expansion of extracellular space decreased the evaporation rate in men. This is demonstrated by the smaller change in body weight induced by exercise. Body weight in females, however, did not change significantly.

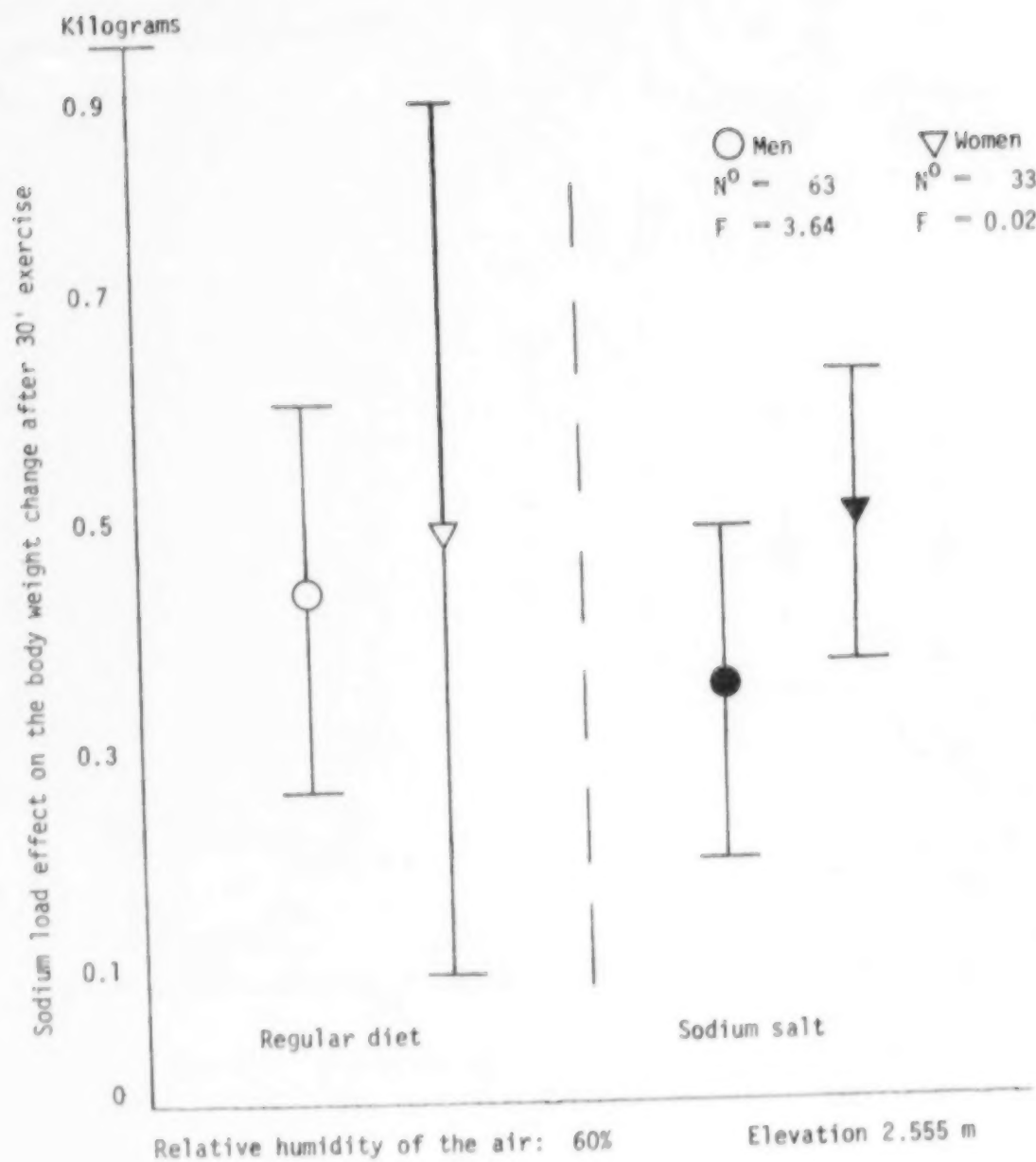


Figure 2. The volume expansion of extracellular space decreased the evaporation rate in men this is demonstrated by the smaller change in body weight induced by exercise body weight in females, however, did not change significantly.

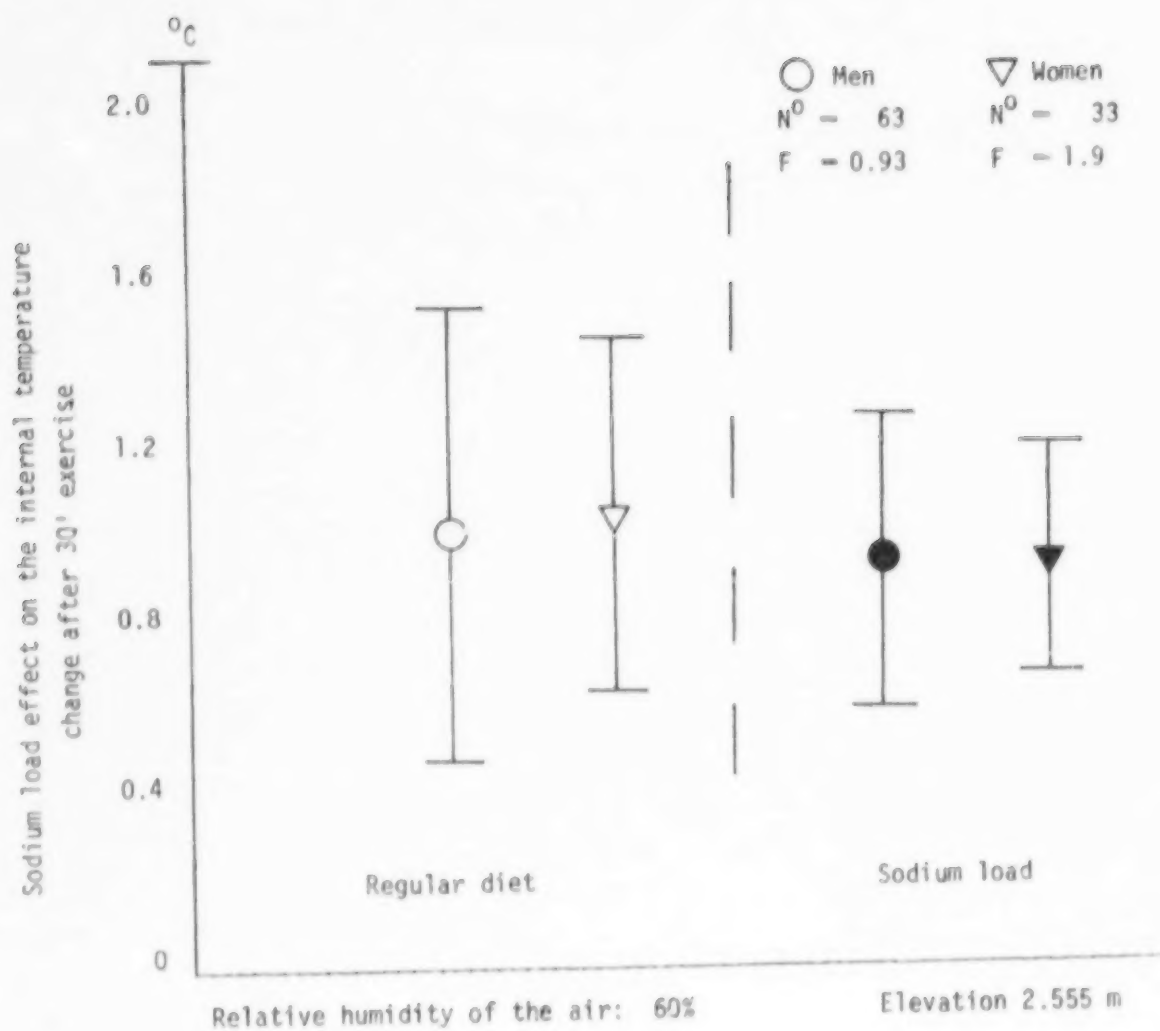


Figure 3. This graph depicts increases of rectal temperature after exercise. The volume expansion of ECF caused lower rectal temperatures during exercise.

Table 1

Heat-loss compared with the increase in rectal temperature
before and after sodium load

	Kcal/hour	$\bar{X} \Delta R. Temp.$
Regular diet	♀ 585.57	1.15 °C
	♂ 523.28	1.14 °C
Sodium load	♀ 609.00	0.96 °C
	♂ 413.19	1.01 °C

In these experiments the volume expansion of extracellular space induced by a salt load permitted the performance of heavy physical work, keeping internal temperatures at a low level despite a reduced evaporation rate through the skin and the lining of the respiratory tract, as demonstrated by the smaller changes in body weight. The formerly described mechanism was made possible because there was a larger amount of interstitial water available at the level of muscle cells "to dilute" the excess of heat generated during muscle work.

Summary

The capacity of the human body for eliminating heat during exercises executed at an altitude of 8,390 ft (2,600 m) above sea level in Bogotá, was studied from the change of internal and external temperatures, and from the evaporation rate from the skin after a 30 minute period of intensive exercises performed by a group of young non-athlete male and female students under the constant indoors environmental conditions of a gymnasium. The temperature of the air and the relative humidity were 65.0° F (18.3°C) and 60% respectively. Measurements were made comparatively before and after the expansion of extracellular fluid (ECF) by a salt load. The results show that individuals taking salt controlled more efficiently the rise in body temperature as demonstrated by the lower internal temperatures recorded after exercises. In all experiments females presented lower internal temperatures than males. The body weight of individuals taking salt for expanding the ECF did not increase significantly.

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An assessment of electromyographic feedback
on the motor control of selected muscles
in spastic cerebral palsy subjects

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Research with biofeedback procedures using non-handicapped subjects has shown that individuals can be easily trained to lower the tension in their muscles. Green, Walters, Green & Murphy (1969) reported that one single session of electromyographic (EMG) feedback was sufficient to reduce forearm activity to near zero. Other investigators (Simard & Basmajian, 1967; Lloyd & Leibrecht, 1971) found that by providing continuous EMG feedback to the subject indicating the varying levels of muscle tension, the acquisition of muscle control was greatly facilitated.

The positive results of biofeedback research with non-handicapped subjects have led to the application of biofeedback techniques to subjects in therapeutic settings. Andrew's (1964) trained stroke patients to successfully flex and extend the involved elbow. Further studies showed that biofeedback techniques helped to improve muscle control in subjects afflicted with chorea (MacPherson, 1967); tension headaches (Budzynski, Stoyva & Alder, 1970); neck injury (Jacobs & Felton, 1969); and to quiet undesirable activity of the peroneus longus muscle (Swaan, vanWieringen & Fokkeman, 1974) and hemiplegic subjects (Basmajian, Kukulka, Narayan & Takeba, 1975).

Research using EMG recordings has shown that individuals afflicted with spasticity are able to quiet down completely the EMG activity in their spastic muscle (Holt, 1966; Basmajian, 1974). However, a review of the literature revealed a paucity of formal experimental research using EMG feedback training in neuro-muscular re-education with spastic cerebral palsy individuals. A number of studies have been carried out with large variations in procedures, particularly in the number of EMG training sessions given to individuals within the same study (Gallon

& Padnes, 1976), in using additional treatment techniques simultaneously with the EMG feedback technique such as Jacobson's relaxation technique (Kleinman, Keister, Riggan, Goldman & Korol, 1976), hemotraining (Amato, Hermismeyer & Kleinman, 1973), psychotherapy (Gallon & Padnes, 1976) and verbal motivation (Gavin & Stephen, 1976). In order to be able to show the unequivocal influence of EMG training, more stringent and systematic experimental conditions are needed (Brudny, Korein, Levidow et al., 1974). This study, therefore, was developed to use EMG feedback as the exclusive treatment technique and exert a systematic and close control over all procedures.

The major objective of this investigation was the assessment of EMG feedback on the motor control of spastic cerebral palsy individuals over selected muscles. As Basmajian et al (1975) has suggested, maximizing residual central nervous system control has not been exploited through traditional methods. More particularly, the following phenomena were investigated: (a) the influence of EMG feedback training on active range of motion of the ankle joint in spastic diplegic cerebral palsy persons, (b) the degree of retention of the acquired range of motion, (c) the learning patterns of response time in relaxation (RTR) in the spastic gastrocnemius and the tibialis anterior. For the purpose of this study, spasticity was defined as hyperactivity of the muscle stretch reflex.

The design selected for this investigation was a single subject design with multiple baselines across physiological behaviors (Kazdin & Kopel, 1975; Martin & Epstein, 1976) and was replicated with three different subjects. Three males and one female with spastic diplegic cerebral palsy, and ranging from 11 to 29 years, participated in this study. Subject I served in the first single subject study. Following the conclusion of this study, subjects II, III and IV participated in replications of this single subject study.

The investigation was divided into four components: the testing period, training periods A and B, and the retention period. Training sessions were given on 10 consecutive days at the rate of two sessions a day. During training period A, subjects received feedback of EMG activity in muscles of the experimental limb. The second limb served

as a control. In period B, subjects received feedback of EMG activity in muscles of both limbs. The retention period consisted of two testing sessions, held at 4 and 9 weeks following the termination of the last training sessions. During periodical testing sessions, active range of motion (ROM) of the ankle joint was evaluated and EMG activity in the tibialis anterior and the gastrocnemius was recorded during ankle joint plantar and dorsi flexions.

The task involved the use of EMG feedback by the subject to rapidly change the EMG activity in a specific leg muscle. Sitting comfortably in an armchair, subjects performed three exercises consisting of contraction and relaxation of the spastic gastrocnemius and the tibialis anterior.

The EMG potentials were recorded by a myograph, an Antogen 1700, which was battery powered and provided a dual channel monitoring system for sequential EMG activity from two electrode sets, consisting of standard EMG silver/silver chloride surface electrodes. The band-pass used was of 100-200 Hz. A mean EMG output was provided by a digital integrator, the Antogen 5100, during one second intervals and was systematically recorded at the beginning and at the end of each session for each exercise during 15 seconds. Active range of motion (ROM) was evaluated by a standard goniometric technique. A measure of learning consisted of the response time in relaxation (RTR) which was defined as the time elapsed between a maximum contraction of a muscle in an exercise and its relaxation to an EMG activity of 1% or 10% of this maximum contraction.

An analysis of the results in subject I and the three replication studies (Table 1) showed a substantial increase in active ROM of the ankle joint in the experimental limb at the end of period A, ranging from 11 to 25 degrees and represented an increase of from 20% to 500% when compared to the initial ROM. A similar improvement occurred in the control limb at the end of period B, ranging from 12 to 30 degrees and represented an increase of from 33% to 450% over the initial active ROM. Retention of the acquired ROM shown in subject I was only replicated with subject IV. Subjects II and III started to lose their newly acquired ROM and declined faster in the control limbs than in the

Table 1

Active range of motion of the ankle in four spastic diplegic cerebral palsy persons during training periods expressed in degrees

		Passive ROM		T1*	T2	T3	R1**	R2
Original study	Subject I	Experimental	70	5	30	40	40	40.5
	Control		60	10	8	38	38	38.5
Replication I	Subject II	Experimental	55	5	24	28	25	23
	Control		55	10	8	20	13	11
Replication II	Subject III	Experimental	40	3	14	16	15	16
	Control		46	4	5	22	10	11
Replication III	Subject IV	Experimental	70	60	72	72	73	73
	Control		65	50	47	63	62	61

* T denotes testing sessions

** R denotes retention sessions.

experimental limbs.

The learning patterns in the RTR of the spastic gastrocnemius in both limbs in all four subjects approximated a negatively accelerated curve during feedback training. No learning occurred, as expressed by the RTR, during training without EMG feedback. During the retention period a low RTR was maintained by all subjects in the gastrocnemius of the experimental limb, while the RTR declined rapidly in the gastrocnemius of the control limb. The results on the learning patterns of the tibialis anterior were less clear.

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Equipment preference and free play practice patterns
of preschool moderately mentally retarded children

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The PREP Program is a play program for preschool moderately mentally retarded children in which motor skill instruction is provided in a free play setting¹. Teacher-child instructional interactions usually occur on a one-to-one basis while the children are engaged in free play throughout the playroom. This preliminary study was conducted to answer a number of basic questions related to the free play behavior of the children in the program.

In one of the few published articles on the play behavior of mentally retarded children, Benoit (1955) described the instructional difficulties, special equipment needs, and environmental constraints that hindered the development of the play skills of these children. He proposed a number of solutions and called for further research efforts; unfortunately, until recently, there has been little published research in this area (Bowers, 1975; Thorum, 1976; Wehman, 1975). A number of research studies on factors related to the play behavior of young children have been published; however, many of these studies have been concerned with play behaviors in relation to social development (Barnes, 1971; Clark, Wyon & Richards, 1969; Parten, 1932; Rubin & Maioni, 1975; Smith & Connolly, 1972), environmental factors in the playroom (Hulson, 1930; Johnson, 1935; Karlsson & Ellis, 1972; Wade & Ellis, 1971), and the salient characteristics of play equipment (Gramza, 1973; Gramza, Witt, Lindford & Jeanrenaud, 1969). A major objective of the PREP Program is to develop the gross motor skills of the children in order to encourage as much culturally normative play behavior as possible. Therefore, the major focus of this study was on the quality of play behavior exhibited rather than the social and

¹The PREP Project is funded by the Government of Alberta: Social Services and Community Health, Services for the Handicapped.

environmental factors associated with play.

Two basic questions regarding the play behavior of the children in the program were posed:

1. Are there wide individual differences in the qualitative and quantitative free play behaviors of the children?

2. What pieces of equipment are used the most frequently and what types of play behavior are exhibited on them?

Method

Subjects

The subjects in this study were 14 moderately mentally retarded preschool children involved in the PREP Program at the University of Alberta. The children were pupils in two classes from a local non-residential school for mentally retarded children. Their mean age at the beginning of the study was 56.2 months (range 42 - 69 months), the means for the 9 boys and 5 girls being 55.4 months and 57.6 months respectively. The children were transported by bus to the PREP Playroom each monday, wednesday, and friday morning for two hours of participation in the program. The PREP Program uses a diagnostic-individualized instruction model to teach motor skills within a free play environment. The children were involved in this program for four months prior to this study; therefore, they were accustomed to the environment and were not a typical group of preschool mentally retarded children (Watkinson, 1976).

Playroom and equipment

The PREP Playroom is a large well ventilated and illuminated room that provided sufficient space for gross motor activities. The following equipment was available for use during each observation session.

Slide. A specially designed plywood slide with a platform 4 feet square and 2 feet high was constructed. An 8 x 4 foot runway angled down to the floor from the square platform. Appropriate matting was placed on the sides of the slide.

Climber. The climbing apparatus consisted of two metal play benches, 40 inches high with 48 x 18 inch rectangular padded platforms;

three benches were spanned by a 10 foot by 20 inch metal ladder, that curved gently upwards, from an attachment height of approximately 30 inches on each bench.

Barrels. Two fibre drums, with one end open, were 3 feet long and had diameters of 24 inches.

Cubes. Three hollow plywood cubes, 28 inches square, with diamond, circle, and square cutouts that permitted the children to climb into them.

Trikes. This term is used to include two preschool tricycles and one pedal car.

House. A 4 x 6 foot area was enclosed by a 54 inch high plywood house-frame. There were small windows, a door, and no roof; the interior consisted of a small cupboard, table, mats, and miniature kitchen utensils.

Mats. The areas around the slide and climber were covered by a one inch thick ensolite mat; this mat measured 20 x 40 feet in area and was adjacent to the far wall of the play area. Three 5 x 10 foot mats consisting of 8 inch thick foam were available for jumping, rolling, and other play throughout the playroom.

Balls. A wide variety of balls were available, these included 8 inch rubber playground balls, tennis balls, and 10 inch light-weight plastic balls.

Bean bags. Different sized bean bags for individual throwing and catching were available in three containers.

Hoops. Ten plastic hula-hoops 36 inches in diameter were available on the perimeter of the play area.

Sticks. Ten Cosom hockey sticks with soft plastic balls were available for individual use.

Small toys. Puppets, pull toys, Fisher-Price trucks and toys were readily available at the front of the playroom.

Play behavior categories and equipment checklist

After careful observation of the freeplay behavior of the children and with the consultation of other staff members, the following four categories of play behavior were defined:

Creative. Creative activity was defined as performing an activity on or with the equipment which was not taught within the class lessons of the program; that is, the activity is a novel use of the equipment. (e.g., sliding down the slide on the back head first; using the push-pull toys on the slide).

Purposeful. Purposeful activity was defined as performing an activity on or with the equipment which makes use of the inherent purposes of the equipment (e.g., jumping on the mats; sliding down slide).

Watching. Watching behavior was defined as attentively watching another child performing on or with a specific piece of equipment (e.g., sitting on the slide watching others use it; standing near the climber watching others use it).

Nothing. A child was performing nothing when he/she is on or holds a piece of equipment and does not perform any meaningful activity with it. (e.g., twiddling a stick; lying on the mats).

The equipment checklist consisted of a data matrix with the names of each piece of available equipment and the names of the subjects listed along the columns and rows respectively. The observers used the following symbols to record the category of play behavior exhibited: creative (C), purposeful (P), watching (W), and nothing (N).

Procedure

The observational study was conducted over five days during the 15-minute free play period at the start of each PREP session. The equipment was placed in a standard position at the start of each period. Four PREP staff members rated the play behavior of the children, in a random order, sampling their behavior in 15-second time periods. The observers sat in four unobstrusive positions on the perimeter of the play area. Each observer rated four children eight times during each of the five sessions. A standard time signal was used to ensure equal time samples. An inter-observer agreement check was conducted during the third 15-minute free play session.

Results and discussion

Play behavior

The percentage of time spent in each play behavior category over the five sessions was calculated. The standard method for computing observer agreement was used; the average inter-observer agreement among the four observers was 83.6%. The chance agreement was 38.3%. A comparison of the above two figures indicates that the inter-observer agreement result was acceptable (Johnson & Bolstad, 1973).

The percentage of time spent in the four play behavior categories for individual children and the group are presented in Table 1.

These results indicate wide individual differences in free play behavior; some children spend 65% of the free play time in purposeful or creative behavior while others spend very little time in these play behaviors. Differences in environmental complexity, availability of equipment, program objectives, and the intact nature of the group in this study make comparisons with studies of intellectually normal children speculative in nature; however, the finding that 6 of the 14 children were involved in watching or nothing behavior for at least 33% of the free play time is in striking contrast to the findings on free play behavior of normal preschool children (Barnes, 1971; Clark et al, 1969; Hulson, 1930; Parten, 1932). Furthermore, the purposeful play behavior category required further revision as it was not sensitive to the wide range of motor skill performance exhibited by the children. In a recent follow-up study, within the PREP Program, a more definitive rating of purposeful play behavior was employed (Watkinson, 1977).

Equipment usage

The amount of time spent in each play behavior category for each piece of equipment was calculated. Table 2 presents the percentage of time spent with each piece of equipment and the percentage of time spent in each play behavior category with this equipment. The slide, small toys, climber, and trikes accounted for more than 65% of the total free play time. The average percentage of free play behavior rated as creative or purposeful on these items was over 80%; while less than 10%

Table 1

Percentage of free play behaviors of children
in the program

Sex	Age*	Creative	Purposeful	Watching	Nothing
F	49	17.5	72.5	10	0
M	66	8.3	83.4	8.3	0
M	56	3.2	90.3	6.5	0
M	54	8.1	78.4	10.8	2.7
M	53	7.5	77.5	7.5	7.5
F	55	16.0	67.7	6.5	9.8
M	52	16.7	62.4	4.2	16.7
F	63	12.8	59.2	12.6	15.4
M	42	8.3	58.4	25.0	8.3
F	52	6.0	36.4	36.4	21.2
M	64	3.3	30.9	2.6	63.2
F	69	0	6.2	12.5	81.3
M	56	0	6.0	19.0	75.0
M	56	6.5	20.0	13.5	60.0
Mean	56.2	10.3	55.5	14.0	20.2

*Age in months.

Table 2

Percentage of free play behavior on or with
each piece of equipment

Equipment	Creative	Purposeful	Watching	Nothing	Total
Slide	10.5	70.2	16.3	3.0	22.5
Small toys	12.0	79.0	7.0	2.0	16.8
Climber	14.2	63.4	14.6	7.3	13.8
Trickies	9.1	72.9	18.9	9.1	12.5
Balls	4.2	95.8	0.0	0.0	8.1
Hoops	25.0	55.0	0.0	20.0	6.1
House	5.6	73.7	17.3	4.4	6.3
Mats	18.6	63.6	8.8	9.0	3.7
Sticks	18.2	36.3	0.0	45.5	3.7
Other					6.5

was classified as "nothing" play behavior. The inclusion of the time spent with balls, hoops, and the house increased the amount of free play time accounted for to over 85%. It is interesting to note that over 70% of the total free play time was spent with equipment designed to elicit gross motor activity. Comparisons with equipment used in other free play studies with intellectually normal children are impossible due to the differences in the play environments (Hulson, 1930; Johnson, 1935; Parten, 1932).

A number of factors might account for the above preferences for certain pieces of equipment. These factors include: the amount of individualized instruction provided on each piece of equipment, the skill levels of the children on specific items, the variety of purposes with which the equipment can be used, and the salient features of the equipment that makes the item attractive. Further research needs to be conducted on these factors in order to provide essential information for the planning of optimal playroom environments for preschool children who are mentally retarded.

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Play patterns of retarded preschoolers

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Play is as essential to the development of the retarded child as it is for other children, both for its intrinsic value and for its contribution to all areas of the child's development. Benoit (1955) stressed the need for research and practice in the area of play for the retardate. He suggested that retardates were deprived of suitable opportunities for play because of a lack of appropriate play equipment and facilities, a lack of imagination on the part of play leaders in finding suitable activities for the retarded, and a hesitance to allow retarded children to play because of the potential danger involved to themselves and equipment. The biggest need, he suggested, was to train teachers, parents and caretakers in how to engage these children in constructive play. Fulfilling this need requires research into the specific play patterns of the retarded and subsequent design and evaluation of strategies of instruction that will effectively improve play skills (Benoit, 1955; Wehman, 1975).

Benoit (1955) suggested that the lack of opportunity to play resulted in deficit play skills in the retarded. Whether this deficit is due in fact to lack of practice or whether the retardate is simply unable, because of cognitive or motivational limitations, to use play time constructively is yet unconfirmed. Certainly it is clear that the retarded child spends less time in play activity. A study of 10 multi-handicapped children 30 to 58 months old (including three mentally retarded children) showed that these children had less total play time than a control group of nonhandicapped children (Gralewicz, 1973). The handicapped children spent 350 minutes in play over a three day period, while the total play time of the controls over the same period was 480 minutes.

During free play the retarded child uses his time less efficiently as well, further increasing his practice deficit. In one study, retarded

children of 4 to 8 years with Down's Syndrome were compared to normal children of the same age on selected aspects of their play (Linford, Jeanrenaud, Karlsson, Witt & Linford, 1971). Filmed sessions of free play revealed that normal children demonstrated much more movement, in terms of speed, frequency and distance covered than the Down's Syndrome children during the same period of time. The two groups differed in their preference for equipment, also, with the normal children spending considerably more time on each chosen piece of apparatus.

An exploratory study on young retarded children in free play was carried out at the University of Alberta (Wall, 1974). Play behavior was categorized as creative, purposeful, watching or nothing. Wide individual differences in the type of play engaged in were noted and it was found that 5 of the 15 children studied spent 65% of their time either doing nothing or watching their classmates at play.

Further confirmation of this inefficient use of play and practice time was found in a later study conducted at the University of Alberta on young trainable retarded children (Noble, 1975). The focus of the study was on both the quantity of time spent constructively during free play and the quality of play skill demonstrated. The results clearly showed that retarded children of 4 to 7 years spent a good deal of their time in complete idleness and that during the time they were active, the sophistication of their play skill was well below that expected of normal children of the same age. As a group, the subjects spent approximately 20% of their free time in complete inactivity, while 33% was additionally spent in simple locomotor activity or un-purposeful interaction with objects. These figures are well above those described in similar studies with normal children (Rosenthal, 1973). The range of time spent in non-play (inactivity) was wide with one child spending 64% of his time doing nothing and 24% of his time in simple locomotion and another child spending 25% of his time in those two categories combined (Noble, 1975).

Clearly then, retardates spend a good deal less time in active play. Whether or not this leads to the deficit in skill observed or whether the skill deficit results in less constructive use of free play time is not clear. Presumably, both effects are possible: the

retardate lacks the play skill required to engage himself constructively during free time and therefore he does not use play time for skill practice, resulting in further play skill deficit in comparison to the normal child.

On the playground and in the play room the retarded child lacks both range and depth in his play skills. This skill deficit has been demonstrated through observations of retarded children in free play. Noble (1975) found only a small percentage of skilled activity (less than 20%) taking place in a play room containing equipment such as ladders, slides, climbing frames, scooterboards, balls and mats. Keeran, Grove and Zachofsky (1969) developed an instrument to assess the play skills of severely retarded children, adolescents and young adults in their interaction with playground equipment and found comparable results. Sequential steps of competency on each piece of equipment were written as an assessment scale. Each scale was divided into proficiency levels representing: (a) complete absence of skill in using the equipment, (b) minimal skill in use of the equipment, (c) use of the equipment with help and (d) proficiency in using the equipment. The investigators found that the merry-go-round was used proficiently by the largest number of experimental subjects (50%) while the swings were used proficiently by 31% of the subjects and the tunnels, wide slide and stair slide were used well by 26%, 20%, and 15% of the subjects respectively.

While very few of the experimental subjects were totally lacking in skill on the apparatus, a fairly substantial percentage of the subjects showed no more than minimal skill in using the swings (51%), the merry-go-round (28%), the wide slide (32%), the tunnels (26%), and the stair slide (58%). The authors did not describe the specific behaviors included in 'minimal skill'. However, one can assume from the competencies described for using the swings that "sits on employee's lap and holds chain" would be considered 'minimal skill'.

The control subjects who were not chosen for special instruction reflected slightly better competencies. In using the swings, merry-go-round, tunnels, wide slide and stair slide the percentages of subjects demonstrating proficiency were 66%, 75%, 69%, 64%, and 58% respectively.

These subjects ranged in age from under 8 years to 29 years however. Clearly they demonstrated a lack of the skills required to use playground equipment constructively and proficiently.

Purpose

The purpose of the present study was to investigate the play patterns of young moderately to severely retarded children. Play patterns were examined before and after an eight month PREP Program of individualized instruction in play skills (Watkinson, 1976). The study was undertaken as part of a programmatic research project whose purpose was to develop effective instructional materials for increasing play skill.

Method

Sample

The sample consisted of 21 retarded children between the ages of 3 and 8 years who attended early childhood classes at a school for trainable mentally retarded children. There were 17 males and 4 females in the sample. Ten of the males and three of the females were diagnosed as having Down's Syndrome. Five children were diagnosed as brain-damaged while the remaining children were reported as being retarded due to unknown causes.

Procedure

The children were videotaped one at a time in a random order during free play time in a play room containing slides, boxes, climbing frames, ladders, tricycles, trampoline, mats and various small pieces of equipment. Eight samples of 100 seconds were taped for each child over a period of three weeks at the beginning and again at the end of the program. After taping a second count was dubbed onto the tape.

Three trained observers analyzed the tapes second by second identifying the behaviors engaged in by the child. The time spent in each behavior was calculated for all behaviors demonstrated in each 100 second sample. Each behavior was then categorized as one of the following:

1. Non-play. The child maintains a static posture or changes posture without locomotion or interaction with objects.

2. Prerequisite play skill. The child demonstrates simple movement skills such as those usually acquired in infancy (e.g., holding, crawling).

3. Primary play skills. The child demonstrates immature execution of the fundamental skills of body awareness, body control, locomotion and object control (e.g., step down, walk fast).

4. Elementary play skills. The child demonstrates mature skill patterns in executing skills of body awareness, body control, locomotion and object control (e.g., throwing, running).

5. Advanced play skills. The child demonstrates competence in integrating or combining fundamental skills of locomotion, body control or object control in interaction with children or special play equipment.

Detailed examples of play behaviors in each of these categories are presented in Figure 1.

Interobserver reliabilities were established using percentage agreement (Johnson & Bolstad, 1973) on randomly chosen samples. The percentages of agreements on 1,500 seconds of observation were 86.26%, 86.13%, and 87.55%. Observer agreement by change was calculated to be 33.00%

Results and discussion

Percentage of time spent in each category of play and non-play over the eight preprogram and eight postprogram assessments were calculated for each individual and the group. Group percentages are presented in Table 1.

Results from the pretest indicated that the children spent a large proportion of their time in non-play (20.65%) and simple movement skills (37.37%) such as walking, crawling or holding. The range of time spent by individuals in these categories was large with some children spending as little as 3% in non-play and one child spending 57% of her time in non-play. Within the sample, 14 children spent at least 15% of their time in complete inactivity. All of these children

	Category 1 NON-PLAY	Category 2 PREREQUI- SITE SKILLS	Category 3 PRIMARY SKILLS	Category 4 ELEMENTARY SKILLS	Category 5 ADVANCED SKILLS
BODY AWARENESS	--	-examining body parts -being in a special place	-removing shoes	-hidding	--
BODY CONTROL	-sitting -lying -standing	-sliding on seat on floor	-continuous rolling -getting onto a box -sliding down wide slide	-hanging -swinging -walking a beam -sliding down long slide	-swinging on a rope -inverted balance -inverted hang
LOCOMOTION	None	-crawling -walking -shuffling	-fast walking -stepping up or down	-running -leaping -jumping -climbing	-run, jump and roll
OBJECT CONTROL	No objects touched	-holding -carrying -dropping -swinging	-putting in -taking out -hurling -pulling -pushing -chasing a rolling ball	-throwing -catching -kicking -tricycling -riding a scooter	-kicking or throwing to target or partner -ball bounc- ing -rope jump- ing

Figure 1. Examples of movement skills found in each of five categories of play.

Table 1

Percentage of time spent in each category of play
in pretest and posttest

	Non-play	Prerequisite skills	Primary skills	Elementary skills	Advanced skills
Pretest	20.65%	37.37%	33.57%	7.75%	.66%
Posttest	9.96%	29.76%	31.99%	25.18%	3.11%

spent a considerable proportion of their remaining time in simple movement skills (Figure 1). In fact, 12 children spent more than 60% of their free play time in these two categories combined. Using Rosenthal's definitions of play behavior (Rosenthal, 1973), all of this time would be categorized as non-play. These results emphasize the need to increase the retardate's ability to use free play time constructively. Since very little of the group's time was spent in skilled activity (8.41% in Categories 4 and 5 combined), it can be assumed that the children lacked the play skills required to make the best use of free time. Only three of the subjects initiated any Category 5 (Advanced Skill) behavior and six subjects demonstrated no behavior at all that could be categorized as either elementary or advanced play skill.

A significant shift in play was seen in the posttest however, with the largest increase occurring in the Category 4 play. This category includes skills such as jumping, running, riding a tricycle, climbing and using a scooterboard. It was on the development of these skills that the individualized instruction was focused. Whereas only 7.75% of the group's time was spent in these activities in the pretest, after the program this increased to 25.18% while non-play behavior dropped from 20.65% to 9.96% of free play time. The latter figure more closely approaches the figure expressed for "idleness" for young normal children (Rosenthal, 1973).

The amount of change in play behavior varied from individual to individual as expected. All but one child increased the amount of time spent in the two highest categories of play, and all children exhibited at least one instance of skilled activity (Category 4 or 5). On the posttest assessment, five of the children spent at least 50% of their time in Category 4 and 5 behavior, and 15 children spent at least 15% of their time in behavior of this type.

One child increased his Category 4 time from 0% to 50.63%. While it cannot be shown conclusively that the change was due to instruction, it is probably worth noting that he received daily instruction in tricycle riding, a skill which he could not initiate at the time of pre-testing but which was seen frequently on the videotapes of the posttest.

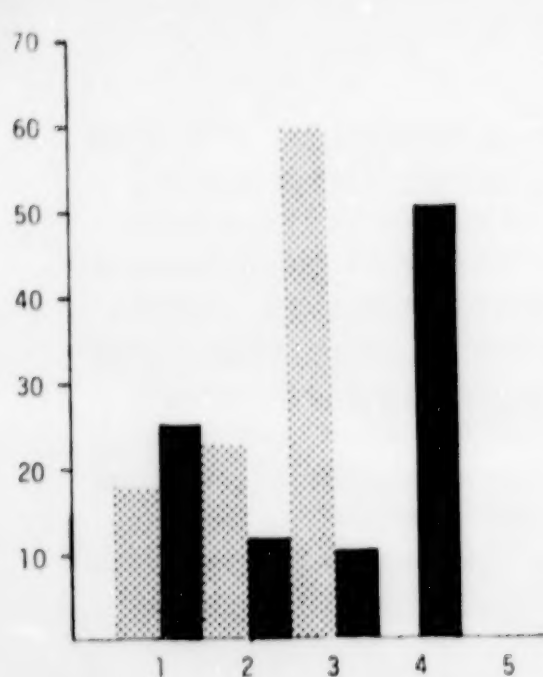
Histograms representing changes in play skill behavior of this subject (S_1) and others are presented in Figure 2.

While some children demonstrated little change in the amount of skilled behavior they initiated, they did at least increase the proportion of time spent in Category 3 behavior (Primary Skills). One boy, for example, (S_2 in Figure 2) increased from 16.75% on the pretest to 43.875% on the posttest in this category. The change probably reflects the instruction he received in running which increased the frequency of fast walking (Category 3) even though he did not achieve a mature pattern of running (Category 4).

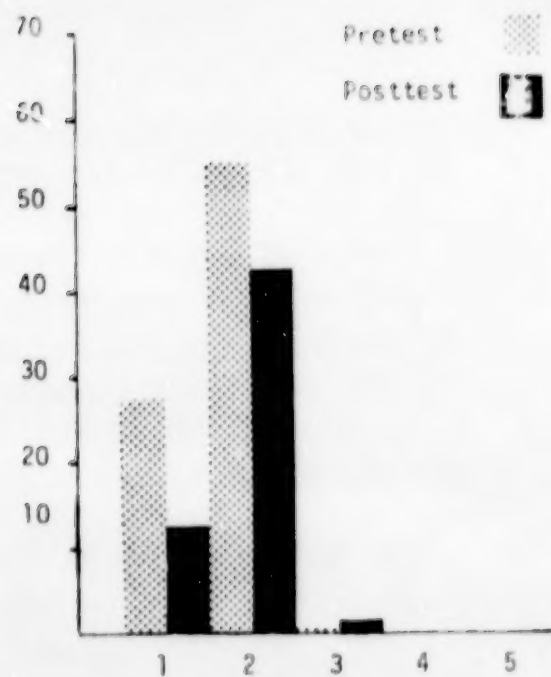
These results show that retarded children spend a good proportion of their time in inactivity and demonstrate relatively little skilled play behavior. However, these play patterns do seem to be subject to change with participation in programs of play skill instruction.

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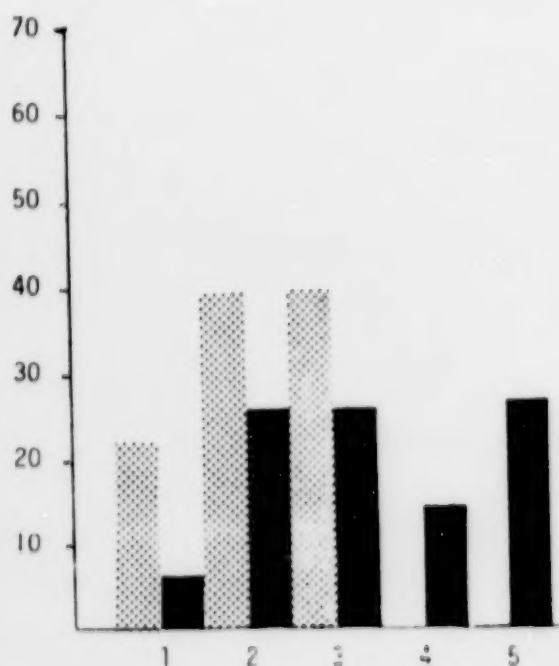
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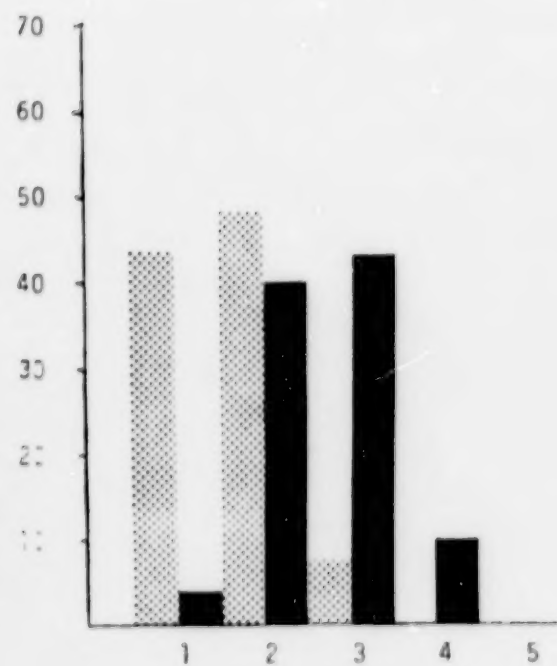
Category of Play (S₁)



Category of Play (S₂)



Category of Play (S₃)



Category of Play (S₄)

Figure 1. Percentage of Free Play Time Spent in each of Five Categories of Play by 4 Subjects on Pretest and Posttest.

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